FINANCIAL AND OPERATIONAL HEDGING OF EXPOSURE TO FOREIGN EXCHANGE RISK: A GCC PERSPECTIVE

A Thesis Submitted in Fulfilment of the Requirements for the Degree of Doctor of Philosophy

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DECLARATION

I certify that except where due acknowledgement has been made, the work is that of the author; the work has not been submitted previously, in whole or part, to qualify for any other academic award; the content of the thesis is the result of work which has been carried out since the official commencement date of the approved research program; any editorial work, paid or unpaid, carried out by a third party is acknowledged; and, ethics procedures and guidelines have been followed.

Ahmad Yousef Bash

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ABSTRACT

This thesis is concerned with the management of foreign-exchange risk. We take the perspective of a domestic firm that is exposed to foreign currencies (such as the GBP, CHF, and JPY) operating in a member country of the Gulf Co-operation Council (GCC). Three important questions are involved in hedging: (i) to hedge or not; (ii) the choice of the hedging instrument; and (iii) measurement of the hedge ratio. Our results show that there is no difference in performance and risk under these three hedging strategies (always to hedge, to hedge or not to hedge, and always not to hedge) for all of the GCC currencies against foreign currencies. Our examination of the effectiveness of three financial hedging techniques—forward hedging, money-market hedging and cross-currency hedging—shows that it makes no difference whether we use forward hedging or money-market hedging (for all of the GCC currencies against foreign currencies). However, in relation to cross-currency hedging, the results are mixed. We find that the effectiveness of cross-currency hedging depends on the correlation between the exchange rates of the base currency against the exposure currency, and the currency used as the hedging instrument. In examining the effectiveness of financial hedging (such as forward hedging) versus operational hedging, (such as risk-sharing arrangements, currency collars, and hybrid arrangements) we find that forward hedging is more effective than either risk-sharing arrangements or hybrid arrangements. However, when compared with currency collars, the results are mixed. Finally, we find that the use of different econometric models to estimate the hedge ratio fails either to add value or improve the effectiveness of the hedge. This implies that there is no need for a sophisticated econometric model to estimate the hedge ratio, because what matters is correlation.

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CURRENCY SYMBOLS

KWD	Kuwaiti dinar
SAR	Saudi riyal
AED	Emirati dirham
QAR	Qatari riyal
BHD	Bahraini dinar
OMR	Omani riyal
USD	United States dollar
GBP	British pound
JPY	Japanese yen
CHF	Swiss franc
EUR	Euro
SDR	Special drawing rights
AUD	Australian dollar
CAD	Candian dollar
DEM	German mark
FRF	French franc

CHAPTER ONE

AN OVERVIEW

1.1 Introduction

After the collapse of the Bretton Woods system and the introduction of flexible exchange rates in the early 1970s—coupled with the tendency of firms to engage in international business—the need has arisen to pay attention to fluctuations in exchange rates. Exchange-rate volatility affects not only firms that operate in international markets, but also domestic firms that compete with other firms that import goods from abroad, as well as purely domestic firms such as utility providers. In other words, even domestic firms that operate in the local market are affected by currency fluctuations (Adler and Dumas, 1984; Aggarwal and Harper, 2010).

This thesis is concerned with the management of foreign-exchange risk from the perspective of a domestic firm operating in a member country of the Gulf Co-operation Council (GCC). This is a bloc of countries in the Middle East that includes Kuwait, Kingdom of Saudi Arabia (KSA), United Arab Emirates (UAE), Bahrain, Qatar, and The Sultanate of Oman. Apart from Kuwait, which pegs its currency to a basket of currencies, all of these countries adopt a fixed exchange-rate regime in which they peg their currencies to the US dollar.[1] While a policy of pegging to the dollar keeps the exchange rate against the dollar stable, the exchange rates against other currencies remain volatile. Since these countries trade more with the European Union, Japan, and China than with the United States, exposure to foreign-exchange

[1] In March 1975, Kuwait adopted an exchange rate regime whereby the domestic currency is pegged to an undeclared basket of currencies. This policy was abandoned temporarily in favour of pegging to the U.S. dollar, a regime that was in operation during the period January 2003-May 2007. During the period covered by this study, the currency was pegged to a basket.

risk is a major issue of concern for businesses using one of the GCC currencies as a base currency. Given that these countries also lack sophisticated financial markets, hedging exposure to foreign-exchange risk becomes a rather challenging task.

1.2 Research Questions and Objectives

The aim of this thesis is to address three important questions, which are always involved in hedging. These questions pertain to (i) whether to hedge or not to hedge; (ii) the choice of the hedging instrument; and (iii) the measurement of the hedge ratio. In this thesis, we study different hedging techniques that can be employed to hedge cash flows and avoid adverse movements of the exchange rate. The main focus will be on:

1- Comparing the effectiveness of three hedging strategies: (i) always hedge; (ii) hedge or no hedge; and (iii) always no hedge.

2- Comparing the effectiveness of three financial-hedging techniques: (i) money-market hedge; (ii) forward hedge; and (iii) cross-currency hedge.

3- Comparing the effectiveness of financial hedging versus operational hedging, such as (i) currency collars; (ii) risk-sharing arrangement; and (iii) hybrid arrangement.

4- Examining whether or not the techniques used to estimate the hedge ratio make any difference to the effectiveness of hedging.

1.3 Significance of the Research

The empirical validity, or otherwise, of the hypotheses to be tested in this thesis have practical implications. For example, the results may be beneficial for the managers of firms engaged in international trade, as well as researchers interested in foreign-exchange risk management. In addition, the results will add value to those agents who employ hedging techniques using the currencies of developing countries that lack sophisticated financial markets. For example in Chapter 7, operational-hedging techniques will be compared with financial-hedging techniques to find out if they can be used instead of financial hedging. Further, investment banks that offer financial-hedging instruments to their clients will become more aware of the efficiency of different techniques that may compete with and replace the traditional instruments. Therefore, those banks can encourage their employees to gain more knowledge and training in financial risk management and start offering their expertise in this area of hedging. Finally, we think that this thesis is unique and will fill a gap in the literature, as nearly all of the countries researched in this thesis adopt fixed exchange-rate regimes that have not been investigated extensively in the literature.

Joseph and Hewins (1991) argue that the increase in international trade, collapse of financial barriers, and growth of multinational corporations (MNCs) have contributed to the increased interest in foreign-exchange exposure. Unexpected changes in exchange rates raise concern in firms to hedge their positions and avoid adverse effects on their values. This raises the topic of financial risk management as one of the important tasks for MNCs (Rawls and Smithson, 1990). It is interesting to note that investment banks recently started offering financial innovation products to these firms, which can be used as hedging tools against adverse movements of exchange rates. Researchers argue that hedging reduces the expected cost of financial distress, as well as expected tax payments, when the tax function is concave (Smith and Stulz, 1985). Hedging also helps to circumvent the underinvestment problem related to the difficulty of obtaining external financing when the company defaults (Bessembinder, 1991; Froot *et al.,* 1993).[2]

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[2] Further discussion of these theories can be found in Chapter 3.

1.4 An Overview of the GCC

Firms in the GCC countries are highly engaged in international trade with other countries. This engagement affects their cash flows due to the uncertainty associated with exchange rate movements. Therefore, different risk management tools should be employed to deal with this situation. The GCC was established in 1981 to enhance co-operating in many fields, such as political, military, security, media, human and environment, legal and judicial, and economics (GCC Secretarial General, 2013).[3]

From 2012 to 2013, the gross domestic product (GDP) of the GCC increased by 4.15 per cent to reach USD 1642.25 billion, an increase from USD 1576.73 billion in 2012 as a result of high oil prices (World Bank, 2015; IMF, 2015).[4] GCC economies are highly dependent on oil and gas production, with proven oil and gas reserves of 29.4 per cent and 22.5 per cent, respectively, of the world's proven reserves in 2013 (British Petroleum, 2014). Oil exports as a percentage of their total exports in 2013 were 94 per cent for Kuwait, 45 per cent for Qatar, 33 per cent for the UAE, 85 per cent for the KSA, 88 per cent for Bahrain, and 77 per cent for Oman (OPEC, 2014; Central Bank of Oman, 2015; Central Bank of Bahrain, 2015).[5] In addition, oil revenues as a percentage of GDP in 2013 were 61 per cent for Kuwait, 43 per cent for KSA, 31 per cent for UAE, 30 per cent for Qatar, 21 per cent for Bahrain, and 77 per cent for Oman (OPEC, 2014; Central Bank of Oman, 2015; Central Bank of Bahrain, 2015). Consequently, these economies benefit from higher oil and gas prices, which would in effect boost their spending on infrastructure-development plans and improve their standard of living.

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[3] The Corporation Council for the Arab States of the Gulf Secretarial General www.gcc-sg.org
[4] World Bank http://data.worldbank.org/ and International Monetary Fund www.imf.org/external/data.htm
[5] Central Bank of Bahrain www.cbb.gov.bh and Central Bank of Oman www.cbo-oman.org

On the other hand, foreign direct investment (FDI) inflows have shrunk lately according to the *World Investment Report* published by UNCTAD (2014). The report shows that growth in FDI inflows to the region in 2013 shrank to -14.5 per cent due to the recent political instability (Arab Spring), delays to projects that are supposed to be joint ventures with foreign firms, and the lack of global liquidity due to the recent financial crisis. Table 1.1 shows both the amount and the percentage change in the FDI inflows and outflows for the GCC for the period 2012–2013.

Table 1.1 Foreign Direct Investment in 2013 (million USD)

Country	FDI inflows in 2013	% change in FDI inflows	FDI outflows in 2013	% change in FDI outflows
UAE	10,488	9.2	2,905	14.5
KSA	9,298	-23.6	4,943	12.2
Qatar	-840	-356	8,021	335.9
Oman	1,626	56.3	1,384	57.8
Kuwait	2,329	-40.7	8,377	159.2
Bahrain	989	10.9	1,052	14.0
Total	23,890	-14.5	26,682	93.2

Source: UNCTAD (2014)

The increase in FDI outflows was mainly driven by sovereign wealth fund investments to capture investment opportunities in developed countries after the financial crisis. This occurred due to the huge accumulated surpluses from oil revenues achieved during the oil boom. According to the Sovereign Wealth Fund Institute (2015), the total asset value of GCC sovereign wealth funds was $2672.7 billion, distributed as follows: Oman $13 billion, Bahrain $10.5 billion, the KSA $762.5 billion, Kuwait $548 billion, Qatar $256 billion, and the UAE $1082.7 billion.

The human development index of the UNDP (2014)—which classifies nations into four groups based on education, life expectancy, and gross national income (GNI)—shows that in 2013, the KSA, Kuwait, Bahrain, Qatar, and the UAE were ranked 34, 46, 44, 31, and 40, respectively. They were classified in the very high human development group, except for Oman which was ranked 56 and was classified in the high development group.

In addition to their dependence on oil and gas production, these economies have undertaken many economic-reform steps to diversify their economies, such as liberalising markets and allowing foreigners to have ownership of real estate; privatising government sectors and allowing foreign companies to access the market by establishing foreign investment offices; amending laws and regulations to enhance the creation of financial centres; and attracting foreign companies with offers such as no tax and 100 per cent ownership (Hanna, 2008).

According to the global financial centres' Index of Yeandle and Danev (2014), the financial centres ranked as follows: Qatar 26, the UAE (Dubai) 29, the UAE (Abu Dhabi) 32, the KSA (Riyadh) 31, and Bahrain 40 in terms of competitiveness compared with other global financial centres, whereas Kuwait and Oman were not included in the ranking. The index is based on six criteria, which are the business environment, taxation, people, infrastructure, reputation, and market access. From an historical point of view, Hanna (2008) argues that GCC economies have been able to deal with unexpected volatility and to absorb the change in the exchange-rate policy without any disruption.

The ranking of the GCC members in terms of the Index of Economic Freedom is presented in Table 1.2. It shows that some of the GCC countries have achieved a good ranking. This index consists of four pillars: (i) rule of law; (ii) limited government; (iii) regulatory efficiency; and

(iv) open markets. The table shows the ranking of GCC countries compared with some developing countries in 2014 for comparative purposes (the higher the ranking, the better).

Table 1.2 Index of Economic Freedom in 2014

Country ranking	Country	Business freedom	Monetary freedom	Trade freedom	Investment freedom	Financial freedom
13	Bahrain	76.3	78.4	78.6	75	80
30	Qatar	71.7	81.2	79.8	45	50
28	UAE	74.4	84.6	82.5	35	50
48	Oman	68.3	73.6	78.7	65	60
76	Kuwait	57.7	73.2	76.7	55	50
77	KSA	67.3	68.7	74.0	40	50
3	Australia	94.6	80.5	86.4	85	90
25	Japan	80.0	87.5	82.4	70	50

Source: Miller et al. (2014)

The *Doing Business Report* published by the World Bank (2014) shows that GCC countries have performed very well in recent years in terms of the ease of doing business. Table 1.3 summarises the ranking of GCC countries relative to some developed countries for comparative purposes.

Table 1.3 Countries Ranking in terms of the Ease of Doing Business

Country	Ranking
KSA	49
UAE	22
Qatar	50
Bahrain	53
Oman	66
Kuwait	86
Australia	11
Japan	27

Source: World Bank (2014)

1.5 Thesis Outline

This thesis consists of eight chapters starting with an introduction and overview in the first chapter. In Chapter 2 we explore the measurements of foreign-exchange risk management and explain the differences between risk and exposure illustrating the different types of exposures that challenge a multinational firm. Chapter 3 demonstrates the different techniques that are used to manage exposure to foreign-exchange risk. These techniques range from financial-hedging techniques to operational-hedging techniques. The empirical results are reported in Chapters 4, 5, 6, and 7. Chapter 4 answers the question: ‘Do we need to hedge?’ by forecasting the spot rate and comparing it with the actual forward rate. The results show that, on average, there is no difference in performance and risk under these hedging strategies for all of the GCC currencies against foreign currencies.

The comparative effectiveness of three financial-hedging techniques (forward hedging, money-market hedging and cross-currency hedging) is examined in Chapter 5. The results show that there is no difference whether we use forward hedging or money-market hedging. However, in relation to cross-currency hedge, the results are mixed, as the effectiveness of the hedge for cross-currency hedging depends on the correlation between the underlying exchange rates.

In Chapter 6 we compare the effectiveness of financial hedging with that of operational hedging. The operational-hedging techniques are the risk-sharing arrangement (RS), currency collars (CC), and hybrid arrangement (HY). The results show that forward hedging is more effective than either risk-sharing arrangements or hybrid arrangements. However, when compared with CC, the results are mixed.

An examination of the different econometric models that are usually used to measure the hedge ratio is presented in Chapter 7. The results show that these models fail either to add value or to improve the effectiveness of the hedge. Finally, we summarise the thesis and present conclusions in Chapter 8.

CHAPTER TWO

THE MEASUREMENT OF FOREIGN-EXCHANGE RISK AND EXPOSURE

2.1 Foreign-Exchange Risk

There is a wide misunderstanding of the difference between the concepts of 'foreign-exchange risk' and 'foreign-exchange exposure', as they are used interchangeably (Levi, 2005). Knowing the difference between these two concepts is very important in international finance. Adler and Dumas (1984) define foreign-exchange risk as the probability of a change in a foreign currency on a specific future date. In other words, it is related to the randomness of the exchange rate. Statistical techniques should be used to measure variation in the exchange rate in relation to its anticipated value. On the other hand, Levi (2005) defines foreign-exchange risk as an unexpected change in the domestic value of assets or liabilities due to an unexpected change in the exchange rate.

This definition by Levi is different from that of Adler and Dumas, in that Levi sheds light on the unexpected change in assets and liabilities as a result of an unexpected change in the exchange rate, not on the uncertainty of the exchange rate itself. For example if the value of an asset does not depend on the exchange rate, then any change in the exchange rate will not affect the domestic asset value, even if the exchange rate is highly volatile. Therefore, exchange-rate volatility creates exchange-rate risk only when it affects the domestic-currency value of payables or receivables. Moosa (2003b) also defines foreign-exchange risk as 'variability of the base-currency value of assets, liabilities, and cash flows (contractual or otherwise) resulting from the variability of the exchange rate'. This relationship can be illustrated as:

$$V_x = S(x/y)V_y \tag{2.1}$$

where V_x stands for the value of assets (or liabilities) for an investor whose base currency is x and who has an investment abroad in currency y valued V_y, and $S(x/y)$ is the exchange rate between x and y.

To calculate the rate of return on an investment made by this investor whose base currency is x for the period t and $t+1$, the following equation is used:

$$(1+R) = \frac{V_{x,t+1}}{V_{x,t}} = \frac{S_{t+1}V_{y,t+1}}{S_t V_{y,t}} \tag{2.2}$$

which gives

$$(1+R) = (1+\dot{S})(1+\dot{V}_y) \tag{2.3}$$

where $\dot{S}$ represents the percentage change in the exchange rate and $\dot{V}_y$ represents the percentage change in the value of assets for the periods t and $t+1$. Foreign-exchange risk initiates from $\dot{S}$, because at time t we do not know $V_{x,t+1}$ due to the ambiguity associated with S_{t+1} .

In finance, risk is usually calculated by a measure of dispersion, such as the variance or its square root (standard deviation), as in the following equations:

$$\sigma^2(\dot{S}) = \sum_{i=1}^{n} p_i \left[\dot{S}_i - E(\dot{S})\right]^2 \tag{2.4}$$

$$\sigma(\dot{S}) = \sqrt{\sum_{i=1}^{n} p_i \left[\dot{S}_i - E(\dot{S})\right]^2} \tag{2.5}$$

$$\sigma^2(\dot{S}) = \frac{1}{n-1}\sum_{i=1}^{n}(\dot{S}_t - \bar{\dot{S}})^2 \tag{2.6}$$

$$\sigma(\dot{S}) = \sqrt{\frac{1}{n-1}\sum_{i=1}^{n}(\dot{S}_t - \bar{\dot{S}})^2} \tag{2.7}$$

Equations (2.4) and (2.5) show the variance and standard deviation equations for an expected change in the spot exchange rate using a probability distribution, whereas Equations (2.6) and (2.7) show the variance and standard deviation for historical observations.

2.2 Foreign-Exchange Exposure

Adler and Dumas (1984) define currency exposure as 'the amounts of foreign currencies which represent the sensitivity of the future, real domestic-currency (market) value of any physical or financial asset to random variations in the future domestic purchasing powers of these foreign currencies, at some specific future date'. They argue that it should have three characteristics: (i) it should be measured by an amount of currency; (ii) from the investor point of view, it should be of any type of asset; and (iii) it should be measured by the available techniques, and hedged by any financial product that exists in the market. They state that currency exposure is measured by the slope coefficient of the regression model between the values of the asset on the exchange rate.

Levi (2005) defines exposure as 'the sensitivity of changes in the real domestic-currency value of assets or liabilities to changes in exchange rates—in other words, it is the amount at risk'. Jorion (1990) defines exchange-rate exposure as the sensitivity of the value of the firm to the randomness of the exchange rate, which is measured by the slope of the regression coefficient between changes in the value of the firm and changes in the exchange rate. Moosa (2010) defines foreign-exchange exposure as 'a measure of the sensitivity of what is at risk to the source of risk'. In other words, exposure measures the sensitivity of the domestic-currency value of foreign-currency items, such as assets, liabilities, and cash flows, to the change in the exchange rate. The source of risk in the foreign exchange is the change in the exchange rate.

Moosa (2010) shows that foreign-exchange exposure could be a long exposure, a short exposure, or a combined exposure. Long exposure is the exposure to foreign assets. As the foreign currency appreciates, the domestic-currency value of foreign assets increases, and vice versa. Therefore, profit is realised when the foreign currency appreciates, as shown in this exposure line equation:

$$\dot{V}_x = \beta \dot{S} \tag{2.8}$$

where $\dot{V}_x$ is the percentage change in the domestic-currency value of assets, $\dot{S}$ is the percentage change in the exchange rate (domestic/foreign), and β is a measure of exposure.

On the other hand, a short exposure is exposure to foreign liabilities. As the foreign currency appreciates, the domestic-currency value of foreign liabilities increases, and vice versa. This implies that a loss is realised when the foreign currency appreciates. Hence,

$$\dot{V} = -\beta \dot{S} \tag{2.9}$$

where $\dot{V}$ is the percentage change in the domestic-currency value of liabilities, $\dot{S}$ is the percentage change in the exchange rate (domestic/foreign), and β is a measure of exposure.

A combined exposure consists of both long and short exposures. The profit or loss under a combined exposure depends on the sensitivity of assets and liabilities to a change in the exchange rate. Assuming that we have foreign-currency appreciation, if assets are more sensitive to changes in the exchange rate than liabilities are, the profit from assets will be greater than the loss from liabilities. If assets are less sensitive to a change in the exchange rate than liabilities are, the loss from liabilities will be greater than the profit from assets. Finally, if assets and liabilities are equally sensitive to a change in the exchange rate, the profit from assets and the loss from liabilities will be equal. Muller and Verschoor (2006) provide an extensive review of the literature on exchange-rate exposure. Given that exposure is represented by Equation (2.8), the following equation shows a direct link between the variance of the percentage change in the domestic value of assets and liabilities, and the variance of the percentage change in the exchange rate by exposure value β^2.

$$\sigma^2(\dot{V}) = \beta^2 \, \sigma^2(\dot{S}) \tag{2.10}$$

which means that the variance is related to the exposure squared.

2.3 Types of Foreign-Exchange Exposure

Foreign-exchange-rate exposure can be classified into three kinds: economic (operating) exposure; transaction exposure; and translation exposure. In their study of the *British Times 1000 Corporations*, Belk and Edelshain (1997) show that the three exposures are linked to each other. They argue that economic exposure in the future will be converted into transaction exposure, and that the choice of the currency by a firm for its future cash flows will consequently affect its revenues and expenses reported in the income statement (translation exposure). Therefore, anything that affects economic exposure will definitely affect the other two exposures. Marshall (2000) points out that these exposures are interrelated and not separate, as a firm might be affected by more than one type.

2.3.1 Economic (Operating) Exposure

Economic exposure—which is also known as operating exposure—arises when an unexpected change in the exchange rate affects the value of the firm. It is also sometimes known as strategic exposure, as it affects the competitiveness of the firm (for related concepts of this type of exposure, see Moosa, 2010). Any expected change in the exchange rate is not counted, because it is already discounted in the cash flows. Under this exposure, changes in the exchange rate affect the firm’s foreign cash flows that are associated with foreign sales, and its domestic cash flows that are associated with local-market sales. Economic exposure is also related to input cost, which is incurred either domestically or abroad.

Moosa (2010) states that economic exposure is unlike transaction exposure, (which depends on the nominal exchange rate), because it depends on the real exchange rate and does not involve any currency conversation of cash flows. According to Belk and Glaum (1992), economic exposure has greater importance than translation and transaction exposures. Economic exposure cannot be measured accurately but it can be forecast using historical data (Moosa, 2010).

One way to estimate exposure is by running a regression similar to Equation (2.8) between the change in cash flows as the dependent variable and the change in the exchange rate as the explanatory variable, in which the exchange-rate coefficient indicates economic exposure. Another method is to regress the percentage change in the stock price (a proxy for the firm value) against the percentage change in the domestic stock-price index and the percentage change in the domestic currency against several foreign currencies (Moosa, 2010). Belk and Glaum (1990) show that MNCs in the United Kingdom do not manage this exposure based on forecasting the exchange rate or risk–return relationship, but based on their competitors' action.

Marshall (2000) shows that because of the difficulty of quantifying it, and the misunderstanding of its definition, economic exposure receives less attention from firms. This difficulty might be due to the lack of effective tools to manage it, and because the cost of managing it is higher than the benefits. A common method to manage this type of risk is pricing strategy, indicating that firms face a relatively high elasticity of demand, which is why they prefer losing some of their profit margin to losing their market share (Marshall, 2000).

Belk and Edelshain (1997) argue that rational behaviour assumed in economics implies that this exposure should be the most important exposure because of its impact on profitability. However, it receives less attention from managers because of the difficulties of quantifying it, and the complexity of predicting it on an ex ante basis. They find that it is the most important currency exposure. However, this is not the case in Finland, as Hakkarainen *et al.* (1998) find that Finnish industrial firms place greater weight on economic exposure than on the other exposures.

2.3.2 Transaction Exposure

Transaction exposure pertains to changes in exchange rates after signing an agreement with another party. Khoury and Chan (1988) define it as a ‘flow concept’. It is similar to economic exposure in the sense that both arise from future unexpected changes in cash flows. However, they differ in the sense that under transaction exposure, there is a contractual agreement between the two parties, whereas such an agreement is not available under economic exposure. An example of transaction exposure is accounts receivable (cash inflows) and accounts payable (cash outflows). In addition, it is related to trade and capital flows, and this is why it is sometimes known as cash-flow exposure. To sum up, this exposure arises when (i) the firm wants to convert foreign-currency receivables or payables items that have already been incurred on its balance sheet into the domestic currency; and (ii) the firm engages in an agreement that involves future cash flows in a foreign currency being converted into the domestic currency.

To measure transaction exposure, a multinational firm that owns subsidiaries around the globe should consolidate the net amount for all the cash inflows and outflows of its subsidiaries. For instance, suppose that a multinational firm based in the United Kingdom with the GBP as its base currency owns two subsidiaries, A and B, in the United States when the USD is the foreign currency. If subsidiary A has cash outflows in USD, then any appreciation of this currency will have an adverse effect on this subsidiary. On the other hand, if subsidiary B has cash inflows in USD, any appreciation of the currency will be beneficial to this subsidiary. If the cash outflows from subsidiary A and the cash inflows to subsidiary B are equal, then the net exposure position for the multinational firm is zero. Hedgers should pay great attention to the following two points:

1- Exposure to a foreign currency that fluctuates widely against the domestic currency has much greater burden of concern than exposure to a foreign currency that is relatively stable.

2- Correlation of the exchange rates is important. If the exchange rates are strongly and positively correlated, this means that appreciation (depreciation) in foreign currencies will lead to appreciation (depreciation) in the domestic currency, more or less proportionally. If the exchange rates are weakly and positively correlated, this means that appreciation (depreciation) in foreign currencies will lead to appreciation (depreciation) in the same direction for the domestic currency, but in different proportions. If the exchange rates are negatively correlated, appreciation in a foreign currency will lead to depreciation in the domestic currency, and vice versa. This might be some sort of natural hedge. A natural hedge could also be established when the two exchange rates are positively correlated and the hedger takes a long position on one foreign currency and a short position on another foreign currency.

Khoury and Chan (1988) show that firms put greater weight on transaction exposure than on economic exposure, which at the time of the study was ignored because of the difficulty of measuring it, and on translation exposure due to changes in a statement of financial accounting standards (SFAS) (from SFAS No. 8 in 1976 to SFASB No. 52 in 1981). In 1976, when SFAS No. 8 was implemented in the United States, translation exposure received greater attention than other exposures (Rodriguez, 1979, 1981; Tran, 1979, 1980). In addition, firms in that period preferred money-market hedging to external-hedging tools (Rodriguez, 1981). Joseph and Hewins (1991) show that MNCs in the United Kingdom place greater emphasis on transaction exposure and aim to minimise it at the same time.

Duangploy *et al.* (1997) also find that US firms place greater emphasis on transaction exposure. Belk and Edelshain (1997) show that the reason why this exposure is emphasised is the ease of measuring and managing it, and the ease of measuring performance and reward. In addition, they argue that it might be because managers prefer short-term exposure (transaction exposure is short-term in nature). Further, Marshall (2000) shows that transaction exposure is considered to be the most important exposure because of its effect on profitability and cash flows.

Hakkaranien *et al.* (1998) argue that for firms that stipulate a targeted percentage of exposure to be hedged, the percentage of transaction exposure hedged will be affected by the uncertainty of the foreign exchange more than translation and economic exposures. According to Belk and Glaum (1990), the management of transaction exposure among MNCs in the United Kingdom is subject to changes over time because of changes in the management of treasury departments and the learning processes of personnel. Bodnar *et al.* (1995) survey non-financial firms in the United States and find that 80 per cent of the firms use derivatives to hedge transaction exposure, while 44 per cent of the firms use derivatives to hedge translation exposure. In addition, they find that the main reason for hedging is to reduce fluctuations in cash flows.

In their more detailed survey, Bodnar *et al.* (1996) find that the objective of the firm in hedging is to reduce fluctuations in cash flows, which could be explained by the theory stating that firms hedge to reduce the cost of financial distress and expected tax payments, improve the underinvestment problem, and secure sufficient internal funds. In addition, they find that 91 per cent of firms reported that they hedge contractual commitments, while 28 per cent of firms hedge translation exposure, and 24 per cent of firms hedge economic exposure. Further, they find that the instrument most used for hedging contractual exposure is forward and (or) futures. Graham and Rogers (2002) find that firms use hedging to boost their debt capacity, but they also find that tax convexity has no relation to hedging.

Bodnar *et al.* (1998) find that foreign-exchange risk is highly managed by derivatives relative to three other risks, which are interest-rate risk, commodities-price risk and equities risk. The results show that 83 per cent of firms manage foreign-exchange risk with derivatives, 76 per cent of them manage interest-rate risk with derivatives, 56 per cent of them manage commodity-price risk with derivatives, and 34 per cent of them manage equity risk with derivatives. Moreover, they find that the reason for using derivatives is as follows: 89 per cent of firms use derivatives to hedge payables and receivables; 39 per cent of firms use them to hedge economic exposure; and 37 per cent of firms use derivatives to hedge translation exposure. Batten *et al.* (1993) find that 61 per cent of Australian firms manage transaction exposure only, while 8.3 per cent of them manage transaction exposure and translation exposure, and 16.6 per cent of firms manage all three foreign-exchange exposures (transaction, translation, and economic exposure).

2.3.3 Translation Exposure

Exposure arises when multinational firms consolidate their financial statements at the end of the financial year and convert all assets, liabilities, revenues, costs, net income, and other financial-statement items of subsidiaries from the foreign-currency value to the domestic-currency value of the parent company. Khoury and Chan (1988) define translation exposure as the 'stock concept'. The process of converting foreign-currency-value items into the domestic currency may produce some gains or losses, depending on the accounting standards that are applied by the multinational firm and on the chosen translation method.

Three types of rates are used to convert currencies from foreign to domestic: (i) the current (or closing rate), which is the rate at which the financial statement is prepared—typically it is at the end of the accounting period (year or quarter or month); (ii) the average rate, which is either the simple average rate calculated as the average of rates at the beginning and the end of the period, or a time-weighted average rate; and (iii) the historical rate, which is the rate prevailing at the time when the asset was purchased or the liability was incurred—it might be out of the regular accounting period for long-term assets and liabilities.

Four methods are used to translate the foreign-currency value of financial-statement items into domestic-currency values: (i) the current or non-current method; (ii) the closing current method; (iii) the monetary or non-monetary method; and (iv) the temporal method. In the United States, there has been greater emphasis on transaction exposure and economic exposure than on translation exposure since the change in the accounting standards from SFAS No. 8 to SFAS No. 52 (Khoury and Chan, 1988). In addition, Marshall (2000) shows that translation exposure is less important in the United States than in the United Kingdom and Asia, which might be attributed to the relative strength of the reporting currency, the accounting standards in each country, and the international business of the firm. On the other hand, Duangploy *et al.* (1997) find that accounting exposure—although it is not real exposure, and the change in the exchange rate does not have a real impact on the firm—is still considered important by companies in the United States, as it is needed to meet the requirements of generally accepted accounting principles (GAAP). Belk and Glaum (1990) confirm this finding in their study on MNCs in the United Kingdom in 1988, in which they find that firms still place great emphasis on accounting exposure.

In their survey, Jilling and Folks (1977) and Rodriguez (1980) also find that translation exposure is very important. Pramborg (2005) finds the same for Swedish firms that focus on reducing fluctuations in accounting numbers. Khoury and Chan (1988) show that firms use the matching-exchange-rate method because of its effectiveness and flexibility to implement, and because it does not involve a relationship with a third party.

The Current or Non-Current Method

In this method, accountants differentiate between short-term items and long-term items on the balance sheet. Short-term items (such as inventory and short-term deposits) are translated at the current closing rates, whereas long-term items (such as long-term debt and real estate) are translated at the historical rates. This means that net current assets are exposed to foreign-exchange risk, whereas long-term assets are not. It also means that a firm with a long-term loan does not need to worry about foreign-exchange risk. Such treatment for long-term assets is not realistic and represents the main drawback of this method (Moosa, 2010).

The Closing (Current) Rate Method

In this method, accountants use the closing rate to translate balance-sheet items at the end of the accounting period. Any increase or decrease in the values of assets or liabilities due to exchange-rate translation will affect shareholders' equity, which means that this item is exposed to foreign-exchange risk. Under SFAS No. 52, an MNE in the United States is required to report gains and losses from translation exposure in the income statement whenever the functional currency for overseas operations is the USD. However, if the functional currency for overseas operations is the foreign currency, the MNE will be required to report gains and losses in the stockholder-equity account on the balance sheet (Duangploy *et al.*, 1997).

According to Moosa (2010), firms in practice use the current closing rate whenever they translate balance-sheet items. Any gain or loss incurred by a transaction is recorded in the income statement. However, if the gain or loss is incurred because of foreign-currency borrowing undertaken as a hedge for net investment in the same foreign currency, it is recorded on the balance sheet under the reserve account. On the other hand, non-transaction gains and losses are recorded on the balance sheet under the reserve account.

The Monetary or Non-Monetary Method

In this method, accountants differentiate between monetary and non-monetary items. Monetary items are items that have a fixed number of units, such as a bond with a face value of USD 1000. On the other hand, non-monetary items are items for which the values move either up or down, such as real estate. Monetary items are translated using the current closing rate, whereas non-monetary items are translated using historical rates. Therefore, net monetary items are exposed to foreign-exchange risk.

The Temporal Method

In this method, the closing rate is applied to items that are recorded in the financial statements at the replacement cost or market value, whereas the historical rate is applied to items that are recorded at historical cost. The reason for this is the implementation of accounting standards to value assets and liabilities. Under the SFAS No. 52, an MNE in the United States is required to report gains and losses from translation exposure in the income statement whenever the functional currency for overseas operations is the USD (Duangploy *et al.*, 1997).

2.4 Conclusion

In this chapter, we explained the difference and the relationship between foreign-exchange risk and foreign-exchange exposure. Further, we explored different types of exposures (such as economic, transaction, and translation) and how the firm can measure them. We illustrated the empirical evidence from the field in relation to each type of exposure. Finally, we talked about translation exposure and discussed the effect of recent changes in accounting standards on the importance of this exposure.

CHAPTER THREE

THE MANAGEMENT OF EXPOSURE TO FOREIGN-EXCHANGE RISK

3.1 Introduction

In this chapter, we explore how firms manage foreign-exchange risk and discuss the need for hedging, followed by the tools that are employed to manage the risk. These tools vary from short-term to long-term tools and can be classified as financial and operational hedging tools. This chapter starts with a discussion of foreign-exchange risk management in Section 3.2, followed by the arguments for and against hedging in Section 3.3. Section 3.4 answers the question of when firms should not worry about hedging; financial and operational hedging techniques are discussed in Section 3.5; in Section 3.6 we provide examples of operational hedging techniques that can be used to manage translation exposure; whereas, Section 3.7 provides examples of financial-hedging techniques for transaction exposure. Management of economic exposure and translation exposure are discussed in sections 3.8 and 3.9. Finally, in Section 3.10, we show how a hedge ratio is measured mathematically; we provide a conclusion in Section 3.11.

3.2 Foreign-Exchange Risk Management

Managing foreign-exchange risk has become a source of concern for firms that trade abroad since the inception of the floating exchange-rate regime. All of the parties involved in international trade and finance (such as investors, suppliers, buyers, brokers, firms, and dealers) have to manage foreign-exchange risk. As the numbers of participants have increased, a large number of hedging instruments have been introduced to hedge exposure and to manage financial risk. Derivatives markets are an example of financial markets that offer financial instruments used for hedging financial risk. They were first introduced to hedge commodity assets, but then developed to hedge financial assets as well (Weber, 2008). Howton and Perfect (1998) study derivative use by firms for *Fortune 500/S&P 500*, and they find that more than 60 per cent of these firms use derivatives, and about 80 per cent use forward and futures contracts to manage currency risk. Marshall (2000) surveys 600 firms located in the United Kingdom, the United States, and Asia, finding that many of them consider foreign-exchange-risk management to be equally or significantly important to in relation to business risk management. He finds that firms in the United Kingdom and the United States manage foreign exchange first to gain certainty about cash flows, and second to reduce the volatility of earnings. However, this is reversed in the case of Asian firms, as they aim first to reduce the volatility of earnings, and second to gain certainty about cash flows. El-Masry (2003) identifies managing cash-flow volatility as the most important reason for firms in the United Kingdom to use derivatives.

3.3 To Hedge or Not to Hedge

Hedging allows firms that are exposed to foreign-exchange risk to minimise the uncertainty associated with unexpected changes in the exchange rate. The decision on whether or not to hedge an open position is a speculative decision, as it depends on the expected spot rate when the payment or transaction settlement becomes due (Moosa, 2010). Many theoretical papers explore the incentive to hedge. For example some papers study the agency problem and the conflict between shareholders' interest and senior claim-holders' interest related to the underinvestment problem. This underinvestment occurs when a firm abandons an attractive investment opportunity because of expensive external financing and the lack of sufficient internal funds that can be used as a substitute (Bessembinder, 1991; Froot *et al.*, 1993; Geczy *et al.*, 1997; Gay and Nam, 1998). Others examine the information effect of hedging, when hedging sends a positive signal showing that the firm is capable of reducing extraneous noise (DeMarzo and Duffie, 1995). Another strand of research deals with risk-averse managers who determine the optimal hedging policy at the corporate level in order to smooth the earnings of the firm, and at the same time maximise the managers' lifetime expected utility without affecting their own income or wealth (Stulz, 1984). Some researchers believe that using derivatives provides the following benefits for firms by allowing them to (i) ensure the stability of cash flows and the availability of internal funds; (ii) reduce the expected cost of bankruptcy; and (iii) generate lower income during high-tax-rate periods and higher income during low-tax-rate periods when the tax schedule is convex (Smith and Stulz, 1985; Stulz, 2003).

Khoury and Chan (1988) show that the hedging decision depends on the type of exposure—and whether it is an asset or a liability—as well as on the expected foreign-exchange rate. Hedging transactions are not free. For example when a firm hedges its position by buying an option, a premium should be paid in advance to acquire that option. If this firm has receivables in a foreign currency, and the exchange rate moves in a favourable direction (foreign-currency appreciation), some gain will be lost because of the premium, and because the firm would be better off if it left the exposure unhedged. On the other hand, if the same firm faces an unfavourable change in the exchange rate (foreign-currency depreciation), leaving the position unhedged will produce losses. Therefore, in this situation, hedging would be the right decision.

3.4 When Should Firms Not Worry about Hedging?

Firms do not have to hedge their position if international parity conditions (such as the unbiasedness efficiency hypothesis, uncovered interest parity, and purchasing power parity) hold, in which case there will be no foreign-exchange risk to worry about. These conditions might hold only in the long run but short-run deviations do exist.

The unbiasedness efficiency hypothesis postulates that the spot rate in the future (when the contract is due) is equal to the forward rate with the same maturity. In other words, the forward rate is an unbiased estimator of the expected spot rate. Therefore, there is no need to hedge the position by using a forward contract, since the bid–ask spread in the forward market is wider than the bid–ask spread in the spot market. This means that the same result, or an even better one, could be obtained by leaving the exposure uncovered. However, leaving the position uncovered yields a high risk in the short run, because mixed results are obtained and little evidence supports this hypothesis (Moosa, 2010). For example the results from studies on individual countries reject the unbiasedness hypothesis, while the results from panel cointegration for 17 OECD countries suggest that the hypothesis is not rejected at the 5% level of significance (Ho, 2002). Copeland *et al.* (2005) show that deviations in the short run are mainly driven by risk premia and expectational errors.

Jung *et al.* (1998) argue that the result depends on the model and whether it employs a level specification or a percentage-change specification, as the two give different results. Wolff (2000) tests whether adding a risk premium can be useful for forecasting the future spot rate, but his model fails to outperform random-walk forecasting. In his study that covers six exchange rates, Moosa (2002) finds that the forward rate is not an unbiased estimator of the spot rate, and is attributing this result to the presence of a risk premium.

Contrary to covered interest parity (CIP), whereby the investor locks his future pay-off by a forward contract, uncovered interest parity (UIP) arises when a domestic investor borrows K amount of money in the domestic currency at cost i% and converts this amount into a foreign currency to be invested at the foreign yield of i^*%. At the end of the investment horizon, this investor should convert the foreign currency back into the domestic currency at the expected spot rate. The uncovered position means that the investor has not entered the forward market, and has left the position open and exposed to spot-rate fluctuations. As a result, this investor is exposed to foreign-exchange risk, because at the beginning of their investment, they do not know the expected spot rate that will prevail in the future.

When UIP holds, the domestic-currency return (with no foreign-exchange risk) equals the foreign-currency return (with foreign-exchange risk), which implies that the interest-rate differential between the two countries will change to offset the change in the exchange rate, in such a way as to keep the domestic-currency return equal to the foreign-currency return. However, in practice, UIP does not hold and the foreign-currency return does not equal the domestic-currency return (Moosa, 2010). UIP depends on both CIP and the unbiasedness efficiency hypothesis.

Purchasing power parity (PPP) is based on the relationship between the exchange rate and the inflation rate for a country relative to another country. It shows that the currency of the country with the higher rate of inflation depreciates against the other, and vice versa. As a result, there will be no real-exchange-rate exposure. However, PPP might hold as a long-run relationship, but in the short run, there are significant deviations (Moosa, 2010). The loss of GBP 58 million by Rolls Royce in 1979 was caused by reliance on PPP, which provides an example of violation of this theory (Dufey and Srinivasulu, 1983).

Another condition under which firms do not have to worry about foreign-exchange risk is when a firm can forecast the exchange rate precisely, in which case it can control foreign-exchange risk and avoid losing some of the gain as in the previous case, when the hedging decision is undertaken as the exchange rates move in a favourable direction. However, in practice, forecasting the exchange rate is not an easy task, as it relies on unanticipated events (Moosa, 2000a). Yet another condition is when shareholders can diversify their portfolios. In this case, there is no reason for the firm to engage in an expensive hedging transaction, because shareholders are naturally hedged.

The capital assets pricing model (CAPM) and the Modigliani and Miller (1958) theorem imply that corporate risk management does not add value to the firm, because shareholders can protect themselves through a diversified portfolio (Dufey and Srinivasulu, 1983). In practice, it might be too expensive for a shareholder to hedge their position and they might not find the appropriate hedging tool to cover their exposure—such as operational hedging. In the real world, managers engage in financial-risk management practices because of imperfections in capital markets (Dufey and Srinivasulu, 1983). Recent studies also contradict Modigliani and Miller. For example Joseph (2000) finds a significant relationship between some financial measures and hedging techniques. This contradicts the view that hedging does not affect the firm's value. According to Stulz (2013), different views on hedging are due to the fact that the costs of risk management are explicit and obvious, whereas the benefits are unobvious and not easily identified. The opponents argue that there is no need for firms to hedge, since stockholders can hedge by diversifying portfolios or by selling the stock of the firm that is exposed to risk. In addition, they argue that a firm can only minimise the total risk that is unrelated to the value of the firm, and what is related to the value of the firm is systematic risk, not the total risk. Therefore, they suggest hedging at the corporate level is worthless and does not add any value. These views are valid only in the presence of perfect capital markets, but capital markets around the globe are imperfect, and this is why the proponents have put forward their own views that support hedging.

The proponents of hedging argue that markets are imperfect because of (i) the existence of information asymmetry; (ii) differential transaction costs; (iii) default costs; and (iv) progressive corporate taxes (Eun and Resnick, 2009). Information asymmetry implies that the managers of a firm know more about its financial position than outsiders do, and that they are capable of taking and managing foreign-exchange exposure. In other words, managers' goals are not aligned with principals' goals. To clarify this situation, suppose that there is a project that needs to be undertaken by the management. The management has to convince the stockholders to increase the equity and invest in this project. However, stockholders will ask about all of the information related to this project before taking a decision, and they may not believe in the management and may oppose such an investment. The case worsens and creates an agency cost of managerial discretion when the project has a negative present value and the managers would benefit from this project at the cost of stockholders (Stulz, 2003).

Differential transaction cost implies that firms have a better advantage in hedging against financial risk at a lower cost than stockholders have. Firms are at an advantage, because they have more hedging tools than stockholders, whereas stockholders might face regulatory obstacles and difficulties imposed on their transactions by financial markets (the size of transactions being an example).

When default costs materialise, the firm is in a better position than the stockholders are in bearing costs and it can reduce the probability of default, which will consequently improve the credit rating and lower the cost of debt (Eun and Resnick, 2009). Stulz (1996) argues that firms with debt are always associated with bankruptcy costs, which can be eliminated as long as the firm employs a risk-management programme to reduce the probability of bankruptcy by minimising the volatility of cash flows to zero. This will in effect boost the value of the firm and also have an effect on its capital structure and ownership structure, due to the lower cost of finance. To illustrate this point, the value of the firm is equal to the present value of its future cash flows. Given that the firm has debt, the present value of the bankruptcy cost should be deducted from the value of the firm. As stated earlier, because risk management eliminates the bankruptcy cost, the value of the firm will be equal to the present value of the cash flows.

A firm also encounters an increased cost of financial distress when it uses debt in its capital structure. The financial-distress cost could arise even if the firm has not filed for bankruptcy, as this is an indirect cost that is related to poor financial performance. When a firm employs debt in its capital structure, interest payments have a tax-deductible feature for the firm; it can increase its debt and interest payments to benefit from this tax-deductibility feature and increase its value. Therefore, the value of a leveraged firm becomes greater than the value of an unleveraged firm. However, this increase in debt is only valid up to a certain level at which time more debt becomes costly, producing a higher cost of financial distress. With a good risk-management programme, firms can reduce the cost of financial distress and enhance the capacity for debt by taking advantage of the tax shield. The optimal capital structure will balance the tax benefit against financial distress (Stulz, 2003). In other words, by minimising earnings volatility through a risk-management programme, firms can boost their debt capacity, which will result in greater benefit from the tax shield and, at the same time, reduce the present value of the expected disruption cost (Stulz, 1984; Smith and Stulz, 1985).

In addition, proper risk management will ensure that the probability of omitting promising investment opportunities due to a lack of external finance is minimised. This means that the underinvestment problem, where the firm forgoes projects with positive NPV due to the principal–agent problem, is solved by ensuring the availability of internal funds.[6] Hagelin (2003) surveys Swedish firms and finds that hedging transaction exposure can add to the value of the firm by reducing the indirect cost of financial distress and circumventing the underinvestment problem, whereas hedging translation exposure shows no evidence related to its effect on the value of the firm.

A progressive corporate tax implies that firms pay more taxes during high-income periods than they save during low-income periods. Therefore, stable before-tax earnings reduce the corporate tax payments as compared with volatile before-tax earnings. In addition, since firms pay higher taxes during higher-income periods, and lower taxes during lower-income periods, a good risk-management programme will ensure lower income during high-tax-rate periods and greater income during low-tax-rate periods. As a result, the present value of tax payments is minimised when the firm is taxed differently at different levels (Stulz, 2003).

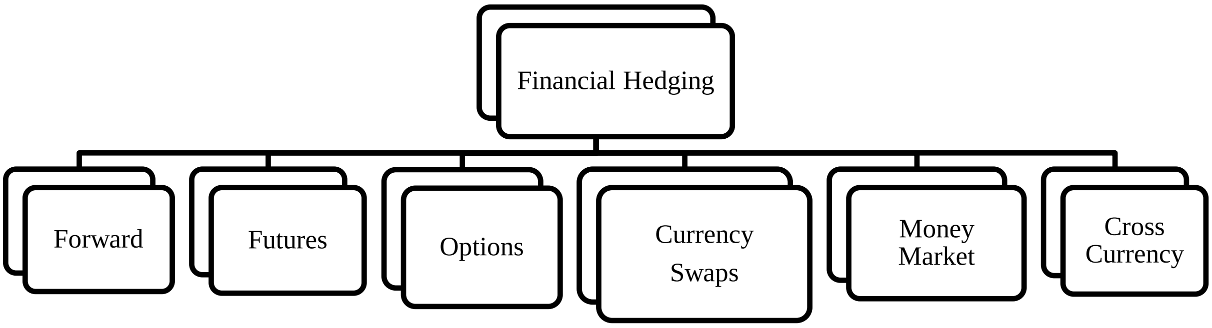
[6] The underinvestment problem occurs when there is a conflict in views between the managers and shareholders of the firm on the method of financing attractive projects when the firm lacks sufficient internal funds. Shareholders do not agree with the management view of investing in such a project through debt finance, as the profit generated by the project in the future will be directed towards bondholders' interest.

3.5 Financial and Operational Hedging Techniques: An Overview

Due to the exchange-rate volatility to which firms are exposed, coupled with the objective of minimising unexpected exchange-rate fluctuations, firms have two techniques to hedge their position. These techniques are financial hedging or operational hedging.

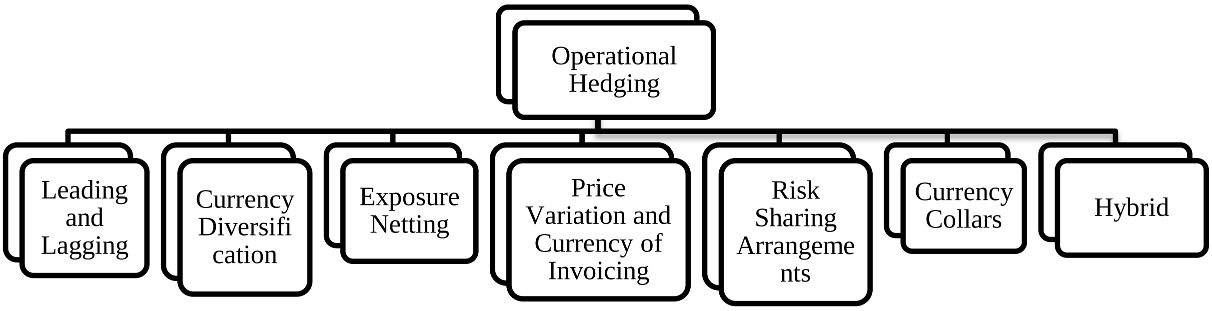
Financial-hedging techniques involve the use of financial derivatives (such as forwards, futures, swaps, and options), cross-currency hedging (buying a third currency in the spot market or buying a derivative instrument of a third currency), and money-market hedging. These financial-hedging techniques are also known as external hedging techniques (Joseph, 2000). According to Zhou and Wang (2013), the use of financial derivatives minimises the foreign-exchange exposure originating from global business activities.

Figure 3.1 Financial-Hedging Techniques



On the other hand, operational-hedging techniques include leading and lagging, currency diversification, exposure netting, price variation and currency of invoicing, risk-sharing arrangements, and currency collars (Moosa, 2010). Allayannis *et al.* (2001) argue that operational-hedging techniques can maximise shareholders' value if they are employed in conjunction with financial-hedging techniques. In other words, Allayannis suggests that operational hedging cannot be used in the absence of financial hedging.

Figure 3.2 Operational-Hedging Techniques



Operational-hedging techniques, which are also known as internal-hedging techniques, are employed when financial-hedging techniques (such as derivatives) are unavailable or are not easy to acquire.

Pramborg (2005) also finds that internal-hedging techniques are widely used among Swedish and Korean firms. For example he finds that matching inflows and outflows is the most popular method in the two countries, followed by the inter-company netting method in Sweden and the leading and lagging method in Korea. Pramborg defines internal hedging as 'leading and lagging of revenues and costs, netting of trade receivables and payables among associated companies, and domestic currency invoicing'. On the other hand, Bodnar *et al.* (1998) find that a large number of firms use foreign-currency derivatives to manage short-term maturity exposure, while few firms do so when they have long-term maturity exposure. Logue (1995) and Chowdhry and Howe (1999) share the point of view that operational hedging should be used to manage long-term exposure, whereas financial hedging should be used to manage short-term exposure. It is notable that Bodnar *et al.* (1998) find that nearly 44 per cent of firms that use derivatives in hedging currency exposure do not have a benchmark against which to evaluate their performance and to decide whether their risk-management process is useful or not.

Naylor and Greenwood (2006) find that 55 per cent of firms in New Zealand use internal-hedging techniques; however, although this percentage is very high for a small open economy, it is still lower than the international norm. Moreover, they find that matching, and leading and lagging are the most commonly used techniques by those firms. El-Masry (2003) conducts a survey covering UK non-financial firms and finds that 67 per cent of firms use derivatives to hedge four types of financial risk—interest-rate risk, foreign-exchange risk, commodity-price risk, and equity-price risk. Of those firms that manage risk by derivatives, 64 per cent of them use currency derivatives to manage foreign-exchange risk.

3.6 Operational Hedging Techniques for Transaction Exposure

Operational-hedging techniques are used when a firm faces difficulties associated with financial hedging, such as high cost or the absence of specific financial instruments. In this case, the firm needs to implement other techniques. In this section we discuss each of these operational techniques.

3.6.1 Leading and Lagging

This method deals with the timing of the realisation of foreign-currency receivables and payables. An example of leading is that if a firm has foreign-currency payables and expects the foreign currency to appreciate, it would be better to meet the payables as soon as possible before the settlement date by amending the agreement with the counterparty. On the other hand, lagging is used when the firm has foreign-currency payables and expects the foreign currency to depreciate, in which case it would be better for the firm to enter negotiations with the counterparty to amend the agreement and delay payment. With respect to receivables, the opposite is true. Contrary to external hedging, this method circumvents maturity problems (Joseph, 2000).

3.6.2 Currency Diversification

When a firm diversifies its foreign-currency portfolio with currencies whose exchange rates are not highly positively correlated (for example y and z), and given that the firm has payables in foreign currency y, an appreciation of y will be offset by the depreciation of another currency z. Moosa (2003b) shows that diversification could be implemented by using a basket of currencies or a composite currency, such as special drawing rights (SDRs).

3.6.3 Exposure Netting

When the firm has both payables and receivables in the same foreign currency, the firm should only hedge the difference between the two exposures (net exposure). This is called natural hedging. However, in real-life situations, firms usually have exposures to many foreign currencies. For example if a firm has payables in foreign currency y and receivables in another foreign currency z (if the exchange rates are highly correlated), the loss in one currency will be offset by the profit in the other currency. After combining the two positions, we will only have residual risk that should be hedged by a derivative instrument.

3.6.4 Price Variation and the Currency of Invoicing

This technique is based on changing the price of exports when the exchange rate changes. For example for a Japanese firm based in Japan that exports goods to the United States, if the USD depreciates the firm will be affected and therefore it should increase the price of its exports to avoid losses from the dollar depreciation. However, this method is not easily implemented because (i) if the competition among other foreign goods is very high, any change in the price will lead to lower demand; and (ii) the prices agreed in the contract are usually fixed and the firm might not be able to change them. To overcome this problem, the exporting firm may invoice the products in the domestic currency and adjust the price of the product in the foreign currency, based on the change in the exchange rate. For example when the foreign currency appreciates, the firm will lower the price of the goods in the foreign currency, or vice versa. The currency of invoicing refers to the choice of the firm to use one currency for both payables and receivables.

3.6.5 Risk-Sharing Arrangements

With this technique, the importer and exporter face the burden of foreign-exchange risk when they both use domestic-currency terms in the invoice for part of the shipment (Moosa, 2010). The parties may agree to add a clause that allows them to set and change the base price due to a change in the exchange rate. This clause is named a price-adjustment clause (Shapiro, 2010). The parties agree on a base rate $\bar{S}$ and a range of exchange rates called the neutral zone with minimum and maximum values of $\bar{S}(1-\theta)$ and $\bar{S}(1+\theta)$, respectively, where θ is between 0 and 1. Suppose that an importing firm adopts x as its base currency and has k payables in foreign-currency y. If the spot rate on the settlement date S_{t+1} is within the neutral zone $\bar{S}(1-\theta) < S_{t+1} < \bar{S}(1+\theta)$, then the cash flow (payables) in the domestic-currency will be calculated by using the base rate $\bar{S}$, which gives $V_x = K\bar{S}$. This suggests that in the neutral zone, the sensitivity of the domestic-currency value to the spot rate on the settlement date is zero, $dV_x/dS_{t+1} = 0$. However, when the spot rate moves outside the neutral zone, payables are calculated as follows. If the spot rate on the settlement date depreciates and falls below the minimum value $S_{t+1} < \bar{S}(1-\theta)$, the domestic currency value of the cash flow will be calculated as

$$V_x = K\left[\bar{S} - \frac{\bar{S}(1-\theta) - S_{t+1}}{2}\right] > KS_{t+1} \tag{3.1}$$

In this case, the payee will benefit because the amount that they will receive is not fully affected by depreciation compared with the no-hedge decision, whereas the payer will suffer because they will not enjoy full depreciation of the currency.

On the other hand, if the spot rate on the settlement date rises beyond the maximum value $S_{t+1} > \bar{S}(1+\theta)$, the domestic currency cash flow will be calculated as

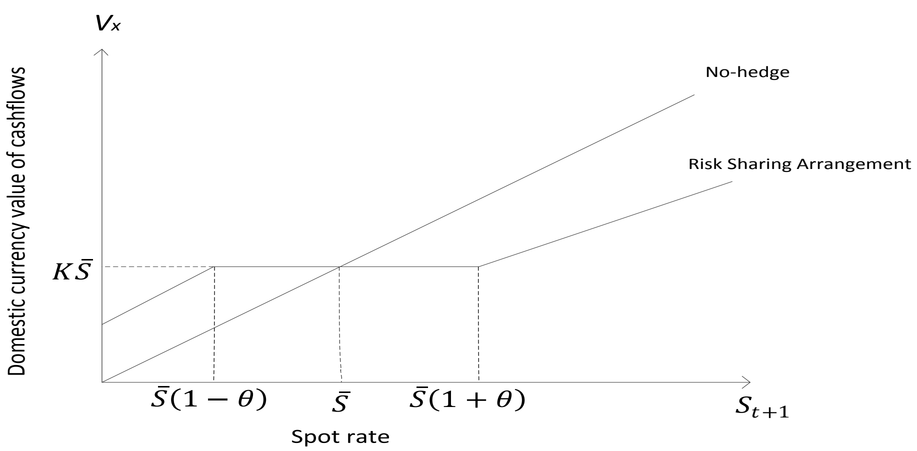
$$V_x = K\left[\bar{S} + \frac{S_{t+1} - \bar{S}(1+\theta)}{2}\right] < KS_{t+1} \tag{3.2}$$

In this case, the payer will benefit because the amount that they will pay is not fully affected by appreciation compared with the no-hedge decision, whereas the payee will suffer because they will not enjoy full appreciation of the currency. As a result, under the no-hedge decision $dV_x = KdS_{t+1}$, as $dV_x/dS_{t+1} = K$, whereas under a risk-sharing arrangement, the risk is shared between the two parties, $dV_x = KdS_{t+1}/2$, which gives $dV_x/dS_{t+1} = K/2$.

In sum, if the spot rate, on the settlement date S_{t+1} is within the neutral zone $\bar{S}(1-\theta) < S_{t+1} < \bar{S}(1+\theta)$, the base rate itself will be used to calculate the domestic-currency value of payables $V_x = K\bar{S}$. If the spot rate exceeds the maximum value $S_{t+1} > \bar{S}(1+\theta)$, the domestic-currency value of payables will be calculated by dividing the difference between the current rate and the maximum value by 2 and then adding the outcome to the base rate and multiplying by k amount using this formula, which gives $V_x = K\left[\bar{S} + \frac{S_{t+1} - \bar{S}(1+\theta)}{2}\right]$.

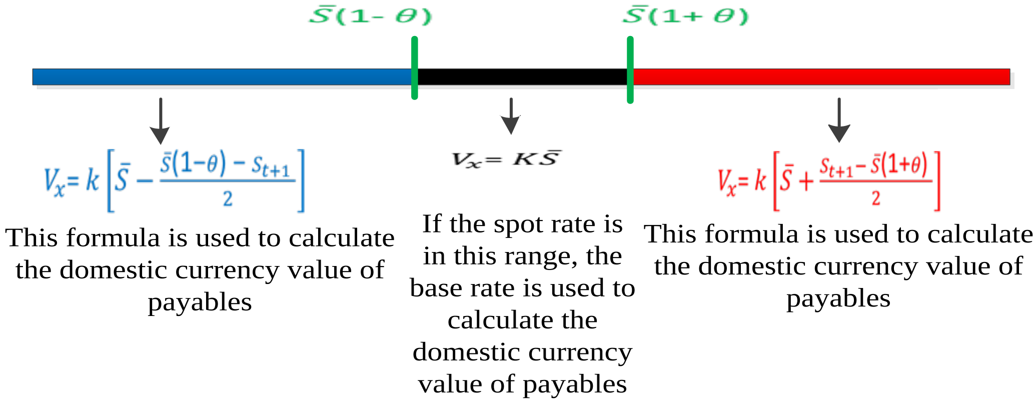
On the other hand, if the spot rate on the settlement date rate falls below the minimum value $S_{t+1} < \bar{S}(1-\theta)$, the domestic-currency value of payables will be calculated by dividing the difference between the spot rate and the minimum value by 2 and then subtracting the outcome from the base rate and multiplying by K amount, which gives $V_x = K\left[\bar{S} - \frac{\bar{S}(1-\theta)-S_{t+1}}{2}\right]$. It should be noted that as θ increases, the possibility that cash flows will be converted at a fixed exchange rate $\bar{S}$ increases, because the neutral zone becomes wider. Therefore, an importer with a highly risk-averse profile will ask for the highest θ to ensure that the cash flows (payables) are converted at a fixed exchange rate, whereas an exporter does not need to engage in hedging at all, as they are not exposed to currency risk and they sell goods (receivables) in the currency y. If the exporter decides to participate in a risk-sharing arrangement due to influence from the importer, they will ask for the lowest θ to avoid converting cash flows (receivables) at a fixed exchange rate. Figure 3.3 clarifies the above example easily by illustrating how a risk-sharing arrangement works in general. Figure 3.4 shows an example of a risk-sharing arrangement for an importer with payables in a foreign currency.

Figure 3.3 Risk-Sharing Arrangement



Source: McDonald and Moosa (2003)

Figure 3.4 Conversion Rates under Risk-Sharing Arrangement

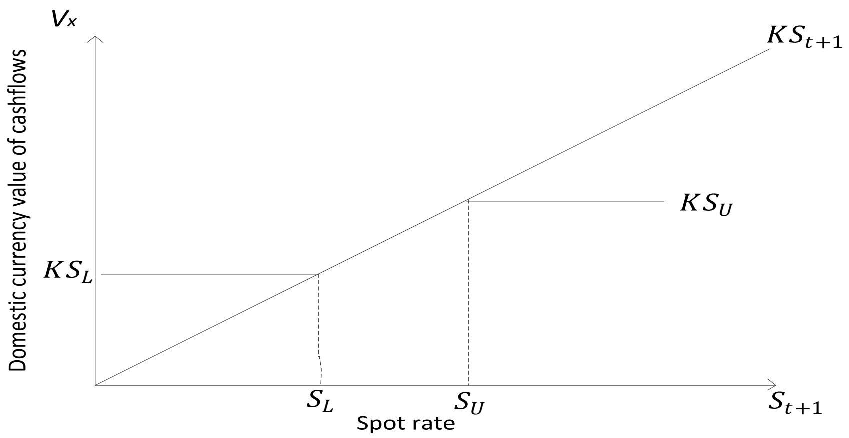


3.6.6 Currency Collars

The currency-collars technique, which is also known as range forward (Moosa, 2003b), involves the determination of a minimum value S_L and a maximum value S_U. If the spot rate on the settlement date S_{t+1} exceeds the maximum value, the two parties use the maximum value, whereas if the spot rate S_{t+1} falls below the minimum value, the two parties use the minimum value. If the spot rate S_{t+1} is in the range between the minimum and the maximum values, the spot rate S_{t+1} itself is used by the two parties. Moosa (2003b) argues that the currency collar works as a trade-off between prospective gain and prospective loss. It can be created by taking a strategy of short-call and long-put with an exercise exchange rate of S_U and S_L, respectively. The pay-off from such a strategy is called the cylinder (Moosa, 2003b; Shapiro, 2010). This means that we set a maximum value (cap) for the payables of an importing company at the expense of setting a minimum value (floor)—that is, scarifying the prospective profit from foreign-currency depreciation (Moosa, 2003b). The opposite applies to an exporting company, in which we set a minimum value (floor) at the expense of setting a maximum value (cap)—that is, scarifying the prospective loss from foreign currency appreciation.

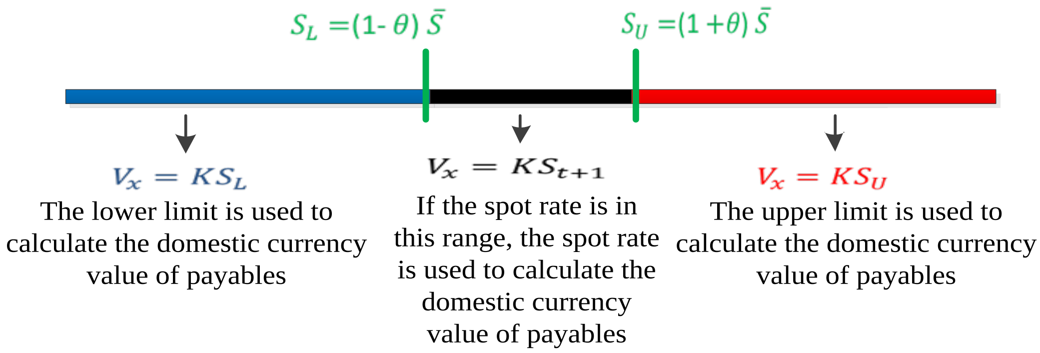
An importing firm that wants to hedge its payables in a foreign currency engages in a currency-collars agreement with the exporter in which they agree on risk parameter θ, a base rate $\bar{S}$, a lower rate S_L and an upper rate S_U. Figure 3.5 illustrates how the currency collars work in general, and Figure 3.6 shows how the currency collars work in the case of payables in a foreign currency.

Figure 3.5 Currency Collars



Source: McDonald and Moosa (2003)

Figure 3.6 Conversion Rates under Currency Collars



On the settlement date, if the spot rate S_{t+1} is within the maximum-minimum range $S_L < S_{t+1} < S_U$, the spot rate itself will be used to calculate the domestic-currency value of payables, $V_x = KS_{t+1}$, which means that the sensitivity of the domestic-currency value of cash flows to the spot rate on the settlement date $dV_x = KdS_{t+1}$, which gives $dV_x/dS_{t+1} = K$. If the spot rate on the settlement date exceeds the maximum rate $S_{t+1} > S_U$, the domestic-currency value of payables will be calculated using the maximum rate itself as $V_x = KS_U$. On the other hand, if the spot rate on the settlement date falls below the minimum value $S_{t+1} < S_L$, the domestic-currency value of payables will be calculated using the minimum rate itself, $V_x = KS_L$. Therefore, at both $S_{t+1} > S_U$ and $S_{t+1} < S_L$, the sensitivity of the domestic-currency value of payables to the spot rate on the settlement date equal to zero, that is, $dV_x/dS_{t+1} = 0$.

It should be noted that, as θ increases, the neutral range widens. Therefore, in contrast to the risk-sharing arrangement (RS), an importer with a highly risk-averse profile under a currency collar will ask for the lowest value of θ so that the possibility of converting their cash flows (payables) at the spot rate on the settlement date is minimised. In addition, when $S_{t+1}< \bar{S}(1-\theta)$ and $S_{t+1}> \bar{S}(1+\theta)$, the exporter is subject to foreign-exchange risk and they will ask for the highest value of θ to ensure converting their cash flow (receivables) at the spot rate prevailing on the settlement date, given that the currency of invoicing is y. To sum up, as long as the currency of invoicing is y, and there is no agreement that obliges the exporter to participate in operational hedging, the importer is the only party that is exposed to foreign-exchange risk with $dV_x/dS_{t+1} = K$, whereas the exporter is not exposed to such risk, given that $dV_y/dS_{t+1} = 0$ and, as a result, they will remain unhedged.

Sometimes, some pressure maybe put by the importer on the exporter to enter into operational hedging. If such pressure exists and the exporter enters into operational hedging (such as a risk-sharing arrangement or currency collars) their main concern will be associated with the amount of risk that will be shifted from the importer to the exporter, which will urge them, the exporter, to ask for the lowest value of risk parameter θ.

3.6.7 Hybrid Arrangement

A hybrid arrangement is a hedging technique based on the weighted average of the two exchange rates under a risk-sharing arrangement and currency collars that is used to convert cash flows. According to Moosa (2011b), an exporter would prefer a hybrid arrangement to both a risk-sharing arrangement and currency collars due to the sensitivity of V_x to changes in θ. The following equations are used to calculate the domestic-currency value of payables under the hybrid arrangement, where β represents the weight assigned to each technique:

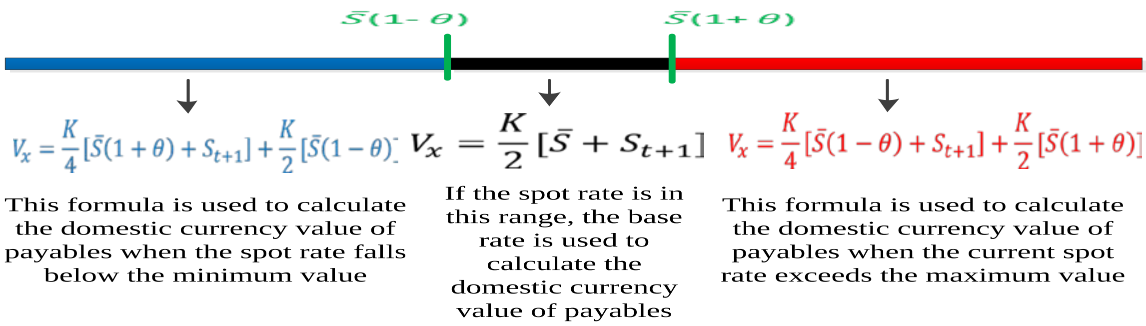
$$V_x = \frac{\beta K}{2}[\bar{S}(1+\theta) + S_{t+1}] + (1-\beta)K\bar{S}(1-\theta) \qquad \text{If } S_{t+1} < \bar{S}(1-\theta) \qquad (3.3)$$

$$V_x = \beta K\bar{S} + (1-\beta)KS_{t+1} \qquad \text{If } \bar{S}(1-\theta) < S_{t+1} < \bar{S}(1+\theta) \qquad (3.4)$$

$$V_x = \frac{\beta K}{2}[\bar{S}(1-\theta) + S_{t+1}] + (1-\beta)K\bar{S}(1+\theta) \qquad \text{If } S_{t+1} > \bar{S}(1+\theta) \qquad (3.5)$$

Figure 3.7 shows how the hybrid arrangement is structured where the cash flows are calculated from the perspective of an importer with payables in a foreign currency, and equal weights of the risk-sharing arrangement and the currency collars ($\beta = 0.5$).

Figure 3.7 Hybrid Arrangement for Equal Weights ($\boldsymbol{\beta = 0.5}$)



In a real-life scenario, in which we have different risk preferences for both the importer and exporter, they will negotiate the value of θ. Hence, they may not reach an agreement regarding the exact value of θ. In this case, they either do not engage in operational hedging or they modify the weights of the risk-sharing arrangement and currency collars to produce a value of the cash flow that is insensitive to changes in the risk parameter that is, $dV_x/d\theta = 0$. This means that the hybrid arrangement solves the problem associated with different preferences for risk tolerance between the two parties to the trade.

Moosa (2009) argues that when both the importer and exporter decide to enter into operational hedging, the importer would prefer to use either of the two hedging techniques, which are the risk-sharing arrangement and the currency collars, as they are better than being unhedged; the exporter would prefer to enter into a hybrid arrangement, as it is better for them than the risk-sharing arrangement and the currency collars. The reason for such preferences lies behind the sensitivity of V_x to changes in θ. For example, for an importer with payables in foreign currency y, when $S_{t+1} < \bar{S}(1-\theta)$, $dV_x/d\theta = K\bar{S}/2$ for the risk-sharing arrangement and $dV_x/d\theta = -K\bar{S}$ for the currency collars. This means that a change in θ has a positive effect on V_x for the risk-sharing arrangement, $dV_x/d\theta > 0$, and a negative effect for the currency collars, $dV_x/d\theta < 0$. When $S_{t+1} > \bar{S}(1+\theta)$, the opposite is true. For example for the risk-sharing arrangement $dV_x/d\theta = -K\bar{S}/2$, which means that $dV_x/d\theta < 0$, and for the currency collars $dV_x/d\theta = K\bar{S}$, which means that $dV_x/d\theta > 0$. These relationships suggest that a change in θ has different effects in the opposite direction on V_x for each of the risk-sharing arrangement and the currency collars. As a result, a hybrid arrangement that combines the risk-sharing arrangement and the currency collars with optimum weights will absolutely eliminate the effect of θ on V_x. Table 3.1 summarises the relationship between θ and V_x for each type of operational hedging from the perspective of an importer with payables in foreign currency y. It shows that the negative relationship between V_x and θ under hybrid hedging is the same as the relationship under the currency collars when $S_{t+1} < \bar{S}(1-\theta)$. On the other hand, the positive relationship between V_x and θ under hybrid hedging is the same as the relationship under the risk-sharing arrangement when $S_{t+1} > \bar{S}(1+\theta)$. In addition, the table shows that the hybrid arrangement of equal weights can minimise the sensitivity of $dV_x/d\theta$ from $\frac{1}{2}\ K\bar{S}$ under the risk-sharing arrangement to $\frac{1}{4}\ K\bar{S}$ under hybrid arrangement, as well as minimising $dV_x/d\theta$ from $K\bar{S}$ under the currency collars to $\frac{1}{4}\ K\bar{S}$ under hybrid arrangement.

Table 3.1 Relationship between the Domestic-Currency Value of Payables V_x and θ

Price condition	RS	CC	HY (β =0.5)
$S_{t+1} < \bar{S}(1-\theta)$	$\frac{dV_x}{d\theta} = \frac{K\bar{S}}{2} > 0$	$\frac{dV_x}{d\theta} = -K\bar{S} < 0$	$\frac{dV_x}{d\theta} = -\frac{K\bar{S}}{4} < 0$
$\bar{S}(1-\theta) < S_{t+1} < \bar{S}(1+\theta)$	$\frac{dV_x}{d\theta} = 0$	$\frac{dV_x}{d\theta} = 0$	$\frac{dV_x}{d\theta} = 0$
$S_{t+1} > \bar{S}(1+\theta)$	$\frac{dV_x}{d\theta} = -\frac{K\bar{S}}{2} < 0$	$\frac{dV_x}{d\theta} = K\bar{S} > 0$	$\frac{dV_x}{d\theta} = \frac{K\bar{S}}{4} > 0$

Source: Moosa (2011b)

Given that Equation (3.3) is used to calculate the cash flow under the hybrid arrangement when $S_{t+1} < \bar{S}(1-\theta)$, we demonstrate how to construct a hybrid arrangement of different weight combinations that provides us with a domestic cash flow V_x that is insensitive to a change in θ. If $S_{t+1} < \bar{S}(1-\theta)$, then

$$V_x = \frac{\beta K}{2}[\bar{S}(1+\theta) + S_{t+1}] + (1-\beta)K\bar{S}(1-\theta) \tag{3.6}$$

which can be manipulated to obtain

$$V_x = \frac{\beta K\bar{S}}{2} + \frac{\beta K\bar{S}\theta}{2} + S_{t+1} + (1-\beta)(K\bar{S} - K\bar{S}\theta) \qquad (3.7)$$

by differentiating Equation (3.7) with respect to θ, we obtain

$$\frac{dV_x}{d\theta} = \frac{\beta K\bar{S}}{2} + \frac{\beta K\bar{S}\theta}{2} + S_{t+1} + (1-\beta)K\bar{S} - (1-\beta)K\bar{S}\theta \qquad (3.8)$$

by equating the first derivative to zero and simplifying the equation, we obtain

$$K\bar{S}\left(\frac{1}{2}\beta - 1 + \beta\right) = 0 \qquad (3.9)$$

which gives

$$\left(\frac{1}{2}\beta - 1 + \beta\right) = 0 \qquad (3.10)$$

Equation (3.10) can be solved for β, which gives $\beta = 2/3$. By substituting this value into Equation (3.6) and simplifying, we end up with the expression

$$V_x = \frac{K}{3}(2\bar{S} + S_{t+1}) \qquad (3.11)$$

The result means that the weight of the risk-sharing arrangement in the hybrid arrangement is equal to $\beta = 0.667$, whereas the weight of the currency collars equals $1 - \beta = 0.333$.

3.7 Financial Hedging of Transaction Exposure

Assume that the (base) domestic-currency and the foreign-currency values are x and y, respectively. An asset denominated in y indicates that the firm has a long exposure, whereas a liability denominated in y indicates that the firm has a short exposure. Table 3.2 illustrates the effect of currency appreciation and depreciation on the base-currency value of the assets and liabilities that are denominated in y when the firm chooses to hedge or not to hedge its exposure.

Table 3.2 Profit and Loss from the Hedge and No-Hedge Decision

	No hedge		Hedge	
	If y appreciates	If y depreciates	If y appreciates	If y depreciates
Long exposure	Profit	Loss	Loss	Profit
Short exposure	Loss	Profit	Profit	Loss

With respect to the no-hedge decision, when the exchange rate moves in a favourable direction (y appreciates when the firm has a long exposure, and depreciates when the firm has a short exposure), the firm makes a profit. On the other hand, the firm incurs a loss when the exchange rate moves in an unfavourable direction (y appreciates when the firm has short exposure, and depreciates when the firm has long exposure). The converse is true when the hedge decision, the opposite, occurs. The firm incurs a loss when the exchange rate moves in a favourable direction (y appreciates when the firm has long exposure, and depreciates when the firm has short exposure). On the other hand, the firm makes profit when the exchange rate moves in an unfavourable direction (y appreciates when the firm has short exposure, and depreciates when the firm has long exposure). The techniques of hedging transaction exposure are described in turn.

3.7.1 Money-Market Hedging of Short-Term Transaction Exposure

Money-market hedging is based on the CIP condition, which suggests that the difference between the spot and the forward rate is related to the interest-rate differential between two countries. CIP implies that a high-interest currency sells at a forward discount, and a low-interest currency sells at a forward premium. In an efficient market in which transaction costs are absent, the interest-rate differential is equal to the forward spread as equilibrium is achieved in the money market (Shapiro, 2010). CIP confirms that the return on unhedged local interest-rate investment and hedged foreign-currency investment will be equal. Therefore, the return differential becomes zero. When such a condition does not hold, an arbitrage opportunity arises by borrowing one currency and investing in the other.

Money-market hedging consists of borrowing in the domestic currency and lending in the foreign currency, or vice versa, to cover expected receivables and payables. This process creates an implicit forward rate $\bar{F}$ (the price of a synthetic forward contract). Therefore, the forward contract can be replicated by money-market hedging, given that CIP holds (Khoury and Chan, 1988). Given that the base currency is x and the foreign currency is y, we can use money-market hedging for payables and receivables as follows. Suppose that a firm has payables of K in foreign currency y due at time $t+1$:

1- At time t, the company borrows the present value of amount K discounted at foreign interest rate i^* from a local bank in the domestic currency. This is KS_t/(1+i^*).

2- The domestic-currency amount is then converted into the foreign currency y at S_t (to obtain the present value of the foreign currency payable) that will be invested at i^*. The amount from this investment is used to cover the payables due at $t+1$.

3- At $t+1$, the domestic-currency loan becomes due, so the firm should repay the principal and interest KS_t (1+ i)/(1+i^*).

4- Given that we pay KS_t (1+ i)/(1+i^*) units of x to obtain K units of y, hence, the implicit forward rate is $\bar{F}_t = \frac{KS_t(1+i)/(1+i^*)}{K} = S_t$ (1+ i)/(1+i^*).

From the above operations, no matter what value S_{t+1} is, the firm realises in advance the domestic-currency value of payables because they will act on $\bar{F}_t$. Therefore, the firm knows in advance how much they will pay in the case of payables, and if $\bar{F}_t < S_{t+1}$, this means that the uncovered interest-rate parity ($\bar{F}_t = S_{t+1}$) has been violated and the hedge decision will be the best decision. However, if $\bar{F}_t > S_{t+1}$, no hedge will be the best decision. Finally, if $\bar{F}_t = S_{t+1}$, the decision on whether to hedge or not to hedge will yield the same result. When we compare the implicit forward rate with the forward rate, if $\bar{F} < F$, this means that a money-market hedge is better than a forward hedge and CIP does not hold. However, if $F = \bar{F}$, then CIP holds and there is no difference between hedging by forward contract and hedging by the money market. One should note that money-market hedging consists of many transactions and could be costly. Therefore, it should only be used if there is no forward contract.

In terms of receivables, we would have the same operations except that the decision would be the opposite. The firm knows in advance how much they will receive, and if $\bar{F}_t < S_{t+1}$, this means that the uncovered interest-rate parity ($\bar{F}_t = S_{t+1}$) has been violated and the no-hedge decision will be the best decision. However, if $\bar{F}_t > S_{t+1}$, hedging will be the best decision. Finally, if $\bar{F}_t = S_{t+1}$, the decision on whether to hedge or not to hedge will yield the same result. Table 3.3 summarises the money-market hedging decision for both payables and receivables.

Table 3.3 Money-Market Hedging Decision for both Payables and Receivables

Price condition	In the case of payables	In the case of receivables
$\bar{F}_t < S_{t+1}$	Hedge	Not to hedge
$\bar{F}_t > S_{t+1}$	Not to hedge	Hedge
$\bar{F}_t = S_{t+1}$	Same result	Same result

Source: Moosa (2003b)

3.7.2 *Forward and Futures Hedging of Short-term Transaction Exposures*

After measuring foreign-currency exposure, the firm can either buy foreign-currency forward or futures contracts to hedge payables, or sell foreign-currency forward or futures contracts to hedge receivables. A forward contract is an agreement between two parties to buy and sell an asset based on the future price at a specific time in the future. One of the parties goes long on the contract (buying the asset), while the other party goes short (selling the asset). The pay-off for the party with a long position is $S_{t+1} - F_t$, whereas the pay-off for the party with a short position is $F_t - S_{t+1}$. F_t stands for the forward price on which both parties have agreed, whereas S_{t+1} stands for the future spot price at the maturity of the contract. The contract is traded over the counter where there is no clearing house or physical exchange to regulate the procedure. Forward contracts are not standardised and are initiated between a bank and a customer, based on their needs.

A futures contract can be used in a similar manner to a forward contract, except that a futures contract is a standardised contract with respect to the settlement date and size. It also requires an initial margin and needs to be marked to market on a daily basis. If the market value of the contract falls below the maintenance margin (which is usually below the initial margin), a margin call is needed to satisfy the requirement. In addition, a clearing house exists for futures contracts that operates as an intermediary that guarantees the performance of the two parties to the trade. These differences make forward contracts more attractive than futures contracts. Clark and Ghosh (2004) recognise four disadvantages of futures contracts: (i) short maturity; (ii) the fixed maturity of the contract size; (iii) infrequent maturity date of the contract; and (iv) margin requirements. Therefore, if the holder of a futures contract expects the interest rate to be constant during the life of the contract, the value of the futures contract will decline relative to a forward contract (Khoury and Chan, 1988). In addition, Khoury and

Chan show that futures contracts are ranked as the third preferred method after forward contracts and the matching method because of cost, liquidity, and expected profit. Lien and Tse (2001) find that hedging effectiveness improves when the hedger uses futures instead of options to hedge currency risk. Moreover, Albuquerque (2007) finds that using futures instead of options improves hedging results when the downside risk becomes the firm's main consideration. This situation is opposed only when the hedger becomes optimistic and less worried about large losses. Hull (2011) summarises the differences between forward and futures contracts as shown in Table 3.4.

Table 3.4 Differences between Forward and Futures Contracts

Forward contract	Futures contract
Private contract between two parties (OTC)	Traded on an exchange
Not standardised	Standardised
Usually one specific delivery date	Range of delivery dates
Settled at the end of the contract	Settled daily – marked to market
Delivery or final cash settlement usually takes place	Contract is usually closed out prior to maturity
Some credit risk	Virtually no credit risk because the clearing house acts as a counterparty and also because of the margin requirements

Source: Hull (2011)

Forward Hedging of Payables

Suppose that an importing firm has a short exposure (payables) of K in foreign currency y to be paid at time $t+1$ in the future (settlement date). If the firm does not buy foreign currency forward F and the spot rate S rises, the firm will incur a loss on the due date. However, if the spot rate falls, the firm will make profit. On the other hand, if the firm is hedged by buying foreign currency forward at F_t (KF_t amount of x) and the spot rate S_{t+1} rises ($KF_t < KS_{t+1}$), a profit will be made because the exchange rate is locked $\pi = K(S_{t+1} - F_t)$. However, if the spot rate S_{t+1} falls, the firm will make a loss.

In terms of the comparison between forward hedging and money-market hedging, if CIP holds, then $\bar{F}_t = F_t$, which means that both forward hedging and money-market hedging are effective and produce the same result. However, if $KF_t < K\bar{F}_t$, then forward hedging is better than money-market hedging. Finally, if $KF_t < K\bar{F}_t < KS_{t+1}$, this means that forward hedging is better than both money-market hedging and the no-hedging decision.

Forward Hedging of Receivables

Suppose that an exporting firm has long exposure (receivables) of K in foreign currency y to be received at time $t + 1$. If the firm does not sell foreign currency forward F_t and the spot rate S_{t+1} rises, the firm will make a profit on the due date. However, if the spot rate S_{t+1}falls, the firm will incur a loss. On the other hand, if the firm is hedged by selling foreign currency forward at F_t (KF_t amount of x) and the spot rate S_{t+1}rises, a loss will be made because the exchange rate is locked $\pi = K(F_t - S_{t+1})$. However, if the spot rate S_{t+1}falls, the firm will make a profit. The profit or loss can be calculated by the difference between F_t and S_{t+1}. Table 3.5 from Moosa (2003b) summarises the decision that should be taken under different prices.

Table 3.5 Hedging Decisions under Different Scenarios

Price condition	In the case of payables	In the case of receivables
$F_t < \bar{F}_t < S_{t+1}$	Forward hedging	No hedge
$\bar{F}_t < F_t < S_{t+1}$	Money market hedging	No hedge
$F_t > \bar{F}_t > S_{t+1}$	No hedge	Forward hedging
$\bar{F}_t > F_t > S_{t+1}$	No hedge	Money market hedging
$F_t = \bar{F}_t = S_{t+1}$	It does not matter	It does not matter

Source: Moosa (2003b)

Forward Hedging in the Presence of Bid–Ask Spreads

Bid–ask rates are rates at which the dealer buys–sells security to or from investors. Spreads are applied to both spot and forward exchange rates and the bid rate is lower than the ask rate. When firms want to hedge their exposure, they cover long exposure (receivables) by buying forward at the ask rate, whereas they cover short exposure (payables) by selling forward at the bid rate. Table 3.6 shows the domestic-currency value of payables and receivables in the presence of bid–ask spread.

Table 3.6 Domestic-Currency Value of Payables and Receivables in the Presence of Bid–Ask Spreads

	In case of payables	In case of receivables
Hedge	KF_{at}	KF_{bt}
No hedge	$KS_{a,t+1}$	$KS_{b,t+1}$

Source: Moosa (2003b)

Option Hedging of Short-Term Transaction Exposure

Options contracts can be call and put options. A call-option contract gives the holder the right to buy an asset at a certain price (exercise price), whereas a put option gives the holder the right to sell an asset at a certain price (exercise price). The option holder could take the following decisions (i) buy a call option; (ii) sell a call option; (iii) buy a put option; and (iv) sell a put option. The date when the option is exercised is called the expiry date. A European option gives the holder the right to exercise only on the expiry date, whereas a US option gives the holder the right to exercise on any date during the option's lifetime. Options can be traded either on an exchange or over the counter.

Options differ from forward and futures contracts, in that options have an up-front cost called the premium and that the domestic-currency value of payables or receivables depends on whether the option is exercised or not. Hull (2011) states that

> *Forward contract neutralizes risk by fixing the price that the hedger will pay or receive, whereas option contract provides insurance for the hedger. They offer a way for investors to protect themselves against adverse price movements in the future while still allowing them to benefit from favourable price movements. Unlike forwards, options involve the payment of an up-front cost.*

The option is used to ensure that the value of payables does not exceed a certain amount and that the value of receivables does not fall below a certain amount (Moosa, 2010). Options could also have a similar effect to the forward contract when both a long call and a short put are exercised (Khoury and Chan, 1988). Option hedging makes firms match and coordinate their investment and financing plans more accurately than forward or futures contracts, since the pay-off of the former (option) is non-linear and the latter (forward and future) is a linear contract (Froot *et al.,* 1993).

In their survey of non-financial firms in the United States, Bodnar *et al.* (1998) find that options are used extensively for managing foreign-exchange risk, relative to their use for managing interest-rate risk and commodity-price risk. In addition, they find that 67 per cent of firms use European-style options, while 41 per cent of firms use US-style options for managing foreign-exchange risk. Firms do not use options for managing foreign-exchange exposure because of the lack of expertise, the high cost associated with options, and because options are not appropriate for the underlying exposure, in which case they use other suitable instruments (Bodnar *et al.*, 1998). El-Masry (2003) finds that the most commonly used instrument in managing contractual commitment by non-financial firms in the United Kingdom is options (25.4 per cent of firms use them).

<u>Hedging of Payables and Receivables with Options Contracts</u>

When a firm has K amount of payables in foreign currency y, it may buy a call option to cover the position against any appreciation in the foreign currency, since the call option on foreign currency gives the firm the right to buy the foreign currency y at exercise rate E. For example, suppose that the firm has a European call option on foreign currency:

1- If at expiry $S_{t+1} > E$, the firm will exercise the contract and buy the foreign currency at exercise rate E. Therefore, the total cost will equal KE plus the cost of premium R, which is KR. This is represented as $(KE + KR)$.

2- If at expiry $S_{t+1} < E$, the firm will not exercise the contract and will buy foreign currency at S_{t+1}. Therefore, the total cost will equal KS_{t+1} plus the cost of premium R for the unexercised option, which is KR. This is represented as $(KS_{t+1} + KR)$.

Therefore, if the firm has payables in a foreign currency and expects the spot rate on the settlement date to rise, it will exercise the call option. In other words, if the firm takes the no-hedge decision, the payables will be KS_{t+1}, and if this amount is greater than the expected value of the hedge decision, the firm should buy the call-option hedge.

In terms of receivables, the firm would use a put option instead of a call option to cover the position against any depreciation in the foreign currency. The decision of the firm will be (i) if at expiry $S_{t+1} < E$, the firm will exercise the contract and sell the foreign currency at exercise rate E. Therefore, the total amount that will be received will equal $(KE - KR)$; and (ii) if at expiry $S_{t+1} > E$, the firm will not exercise the contract and will sell the foreign currency at S_{t+1}. Therefore, the total amount that will be received is $(KS_{t+1} - KR)$.

Cross-Currency Hedging

Cross-currency hedging can be implemented by either taking a position on another foreign-currency derivative or another foreign-currency spot rate. When a derivative instrument such as a forward or an option is unavailable for a certain foreign currency y, the firm can take the position of buying or selling a derivative for another foreign currency z, which has an exchange rate against the domestic currency $F(x/z)$, that is correlated with the original exchange rate $S(x/y)$. For example if company A has foreign exposure of currency y but there is no derivative instrument for currency y, then this firm can take a position of buying or selling derivatives for the z currency, based on the strong correlation between $S(x/y)$ and $F(x/z)$.

Another technique for cross-currency hedging instead of using currency derivative, is when the firm takes a spot position on another foreign currency z. For example, suppose that a firm has a short position on currency y, it can hedge the position by taking a long position on a third currency z (given that the foreign-currency exchange rate $S(x/y)$ and the third-currency exchange rate $S(x/z)$ are highly correlated), and vice versa. For example if a firm has payables (short position) in currency y, it can buy (long position) currency z. Therefore, if currency y appreciates, the third-currency exchange rate $S(x/z)$ will also rise, which means that the loss that would occur from currency y is offset by the profit from currency z. This technique relies on the spot market, not the forward market. Schwab and Lusztig (1978) argue that if the transacting partners aim to minimise the risk and their concern is a nominal return and cost, a mix of the two currencies for the two parties should be used; if the concern is the real return and cost based on the reference basket, a third currency should be used.

3.7.3 Hedging Long-Term Transaction Exposure

According to Moosa (2010), three techniques can be used to hedge long-term exposure (a length of five years or more) of receivables and payables when the exposure is estimated. These are (i) long-term forward contracts; (ii) currency swaps; and (iii) parallel loans.

Long-Term Forward Contracts

Long-term forward contracts are offered by commercial banks only to top-rated companies, because of the risk associated with this type of contract. The normal forward contracts come with maturities of 30 days, 60 days, 90 days, 180 days, and 360 days. For maturities greater than these, banks can customise contracts depending on their customer's needs.

Currency Swaps

A currency swap is the exchange of a certain amount for two different currencies between two counterparties at the inception of the contract, and they will be re-exchanged at the end of the period, based on a predetermined agreement. It is used to manage foreign-exchange risk (Shapiro, 2010). To illustrate the swap, consider company A working in Kuwait, which borrows Kuwaiti dinar at a fixed interest rate, and company B, working in the United States, which borrows USD at a fixed interest rate. Both institutions agree to swap the cash flows so that each company will have its desired currency of cash flows.

Parallel Loans

According to Moosa (2010), parallel loans are similar to currency swaps but they do not involve foreign-exchange risk or transaction risk. However, a firm that wants to hedge using a parallel loan should find a counterparty that needs the exact amount of the loan.

3.8 Managing Economic (Operating) Exposure

As stated earlier, this type of exposure depends on the change in the real exchange rate. When the real exchange rate changes, the revenues and costs of the firm will also change and this will affect net operating income. For example if the firm has elastic demand for its products, a real appreciation of foreign currency will increase both domestic and foreign sales and, at the same time, will increase the cost of raw material and the foreign-borrowing costs. The outcome of this situation depends on the elasticity of revenues and costs with respect to the exchange rate. If the revenues are highly sensitive, and costs are less sensitive to appreciation of the foreign currency, then the net result will be positive due to the increase in net operating income. On the other hand, if costs are highly sensitive, and revenues are less sensitive to appreciation of the foreign currency, then the net outcome will be negative due to the decrease in net operating income. It works the other way around if the firm encounters real depreciation of foreign currency.

To hedge this type of exposure, a firm might focus on changing the sensitivity of the revenues and costs to changes in the exchange rate by restructuring its operations. For example if the firm is suffering from negative net operating income, it should increase the sensitivity of revenues and, at the same time, reduce the sensitivity of costs to an exchange-rate change. This might be achieved by increasing the expenditure on advertising and relocating its production sites. Moosa (2010) shows that this exposure could be managed by (i) diversifying the markets in which the firm sells products or from which it imports raw material; (ii) building or shifting production sites abroad; and (iv) changing the foreign-currency debt level. Aggarwal and Soenen (1989) state that marketing, production, and financial strategies should be used by firms with long-term foreign-exchange exposure, instead of other traditional techniques.

Marshall (2000) shows that forward contracts, swaps, and options are the most commonly used instruments as external hedging tools, whereas pricing strategy, planning, and raising productivity are widely used as internal-hedging tools. He argues that it is not unexpected that many firms do not manage their economic exposure. The reasons behind that are the possibilities that the cost of managing the exposure exceeds the benefit (which is not easily quantifiable), and the absence of an effective tool to manage the exposure.

3.9 Managing Translation Exposure

Although translation exposure does not affect the economic value of firms, it does affect the earnings per share data and other financial variables appearing on the financial statements. Firms manage this exposure by using three different techniques: fund adjustment, forward contracts, and exposure netting or balance-sheet hedging (Moosa, 2010). Fund adjustment is a procedure that is undertaken to affect the foreign cash flows generated by subsidiaries or projects of the firm in a way that minimises exposure to foreign-currency risk. For example consider a parent firm with foreign-currency cash inflows generated by a subsidiary: if the parent firm expects the foreign currency to depreciate, it could try to speed up the payments of dividends or use the leading method to avoid currency depreciation. Another solution is to use a stable currency in pricing exports, while using domestic currency in pricing imports, or investing in stable currency instruments (Moosa, 2010). A forward contract, which we have already discussed, basically entails selling an amount of the foreign currency forward (the amount of cash inflows of a currency that is expected to depreciate) in the future. For example suppose that the parent firm is based in Kuwait and has a subsidiary working in the United Kingdom with cash flows in GBP (as the base currency for the subsidiary), which should be transferred from the United Kingdom to Kuwait. If the parent firm expects the foreign currency, GBP, to depreciate, it should sell a forward contract on the foreign-currency cash flows.

Exposure netting involves hedge of net exposure that is calculated as the difference between foreign-currency payables and receivables. Balance-sheet hedging pertains to the difference between assets and liabilities on the balance sheet in the same currency. Firms should not worry about foreign-exchange risk if the value of assets is equal to the value of liabilities, because no effect will emerge from changes in the exchange rate on value. Marshall (2000) shows that balance-sheet hedging is the most widely used method, followed by netting and matching. On the other hand, although few firms use external methods to manage translation exposure, forward contracts, options, and swaps are the most commonly preferred methods.

3.10 Measuring the Hedge Ratio

Hedging is usually aimed at protecting the hedger from unfavourable movements in the exchange rate. It consists of taking an opposite position on a financial derivative instrument, or another asset, so that the loss from one position can be offset by the profit from the other position. For example a firm with a long position can hedge its position by taking a short position to avoid unfavourable movements in the exchange rate. However, the question that arises is by how much they should hedge. In other words, should they hedge the full exposure so that the hedge ratio is 1, or should they hedge a fraction of the exposure? Moosa (2003b) argues that using a hedge ratio of 1 is not always the best hedging decision, as it might not eliminate the total risk, or it might reduce the risk slightly, but not completely. To determine the hedge ratio, the firm should determine the size of the financial derivative that will be used as a hedging instrument against the unhedged position. If they are equal, then a hedge ratio of 1 is obtained (perfect hedge). Consider the following formula

$$R_H = R_U - hR_A \tag{3.12}$$

where R_H is the rate of return on the hedged position, R_U is the rate of return on the unhedged position (spot), R_A is the rate of return on the hedging instrument, and h is the hedge ratio. For a perfect hedge in which $R_H = 0$, the hedge ratio becomes

$$h = \frac{R_U}{R_A} \tag{3.13}$$

Otherwise, it is not the optimal hedge ratio as the hedge ratio will be greater or less than 1.[7]

3.10.1 Mathematics of the Hedge Ratio

The rate of return on the hedged position equals the value of the cash position at the end of the investment period plus the rate of return on the hedging instrument. Given that we have a forward or future, and given that we have a long position in the spot currency, the size of the hedging instrument should be equal to the spot currency position but in the opposite direction—as in Equation (3.12). For example with a long currency spot, we should short

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[7] Moosa (2003b) states that for a perfect hedge, exchange rates of the unhedged position (spot) and hedged instrument (forward as an example) should be perfectly correlated. If they are not perfectly correlated, and they want to obtain a perfect hedge in which $R_H = 0$, they should have a hedge ratio greater than 1 when $R_U > R_A$ or a hedge ratio less than 1 when $R_U < R_A$.

currency forward and vice versa. The h in Equation (3.12) is simply a slope coefficient calculated as

$$h = \frac{Cov(R_U, R_A)}{Var(R_A)} \tag{3.14}$$

to calculate the variance of the hedged portfolio

$$\sigma^2(R_H) = \sigma^2(R_U - hR_A) \tag{3.15}$$

Therefore,

$$\sigma^2(R_H) = \sigma^2(R_U) + h^2\sigma^2(R_A) - 2\, h\, cov(R_U, R_A) \tag{3.16}$$

To minimise the variance, we take the first-order derivative of Equation (3.17) and equate it to zero as

$$\frac{dVar(R_H)}{dh} = 2h\, \sigma^2(R_A) - 2\, cov(R_U, R_A) = 0 \tag{3.17}$$

$$2h\, \sigma^2(R_A) - 2\, cov(R_U, R_A) = 0$$

which gives us a minimum-risk hedge ratio as

$$h = \frac{cov(R_U, R_A)}{\sigma^2(R_A)} \tag{3.18}$$

The hedge ratio is estimated using ordinary least squares (OLS) regression as in

$$\Delta p_{u,t} = \alpha + h\Delta p_{a,t} + \varepsilon_t \tag{3.19}$$

where $p_{U,t}$ and $p_{A,t}$ are historical prices in logarithmic form under unhedged position $p_{u,t}$= $s(x/y)$ and hedged positions $p_{a,t}$= [$f(x/y)$, $\bar{f}(x/y)$, $s(x/z)$] for forward hedge, money-market hedge, and cross-currency hedge, respectively. Given that the coefficient of determination R^2 is used to measure the goodness of fit, we can use this R^2 to measure the effectiveness of the hedge. Obtaining $R^2 = 1$ means that we have a perfect hedge and the hedged position has no variance, whereas obtaining $R^2 = 0$ indicates that the hedged position has the variance of the unhedged position (Moosa, 2003b). According to Stulz (2003), the R^2 shows the extent to which the independent variable explains the variance of the dependent variable. Moosa (2003b) argues that we can evaluate the effectiveness of the hedge by calculating the variance ratio (VR) and variance reduction (VD) as:

$$VR = \frac{\sigma^2(R_U)}{\sigma^2(R_H)} = \frac{\sigma^2(R_U)}{\sigma^2(R_U)+h^2\sigma^2(R_A)-2\,h\,cov(R_U,R_A)} \tag{3.20}$$

and given that

$$\rho = \frac{cov(R_U,R_A)}{\sigma(R_U).\sigma(R_A)} \tag{3.21}$$

where ρ is correlation coefficient

$$cov(R_U,R_A) = \rho\,.\,\sigma(R_U).\,\sigma(R_A) \tag{3.22}$$

By substituting Equation (3.22) into Equation (3.18), we get

$$h = \frac{\rho\,.\sigma(R_U).\sigma(R_A)}{\sigma^2(R_A)} = \rho.\frac{\sigma(R_U)}{\sigma(R_A)} \tag{3.23}$$

This equation illustrates the relationship between the hedge ratio and the correlation coefficient. If $\sigma(R_U) = \sigma(R_A)$, the hedge ratio will simply be the correlation coefficient. From Equations (3.20) and (3.23), we obtain

$$VR = \frac{\sigma^2(R_U)}{\sigma^2(R_U)+[\rho^2.(\frac{\sigma^2(R_U)}{\sigma^2(R_A)})\sigma^2(R_A)]-2\,\rho.(\frac{\sigma(R_U)}{\sigma(R_A)})\,\rho\,.\sigma(R_U).\sigma(R_A)} \tag{3.24}$$

which can be simplified as following to obtain Equation (3.25)

$$VR = \frac{\sigma^2(R_U)}{\sigma^2(R_U)+\rho^2\sigma^2(R_U) - 2\rho^2\sigma^2(R_U)}$$

$$VR = \frac{\sigma^2(R_U)}{\sigma^2(R_U)-\rho^2\sigma^2(R_U)}$$

$$VR = \frac{1}{(1-\rho^2)} \tag{3.25}$$

and given that

$$VD = 1 - \frac{1}{VR} \tag{3.26}$$

To prove it, we carry out cross multiplication for Equation (3.26) to obtain Equation (3.27)

$$VR - VR\rho^2 = 1$$

$$VR\rho^2 = VR - 1$$

$$\rho^2 = \frac{VR}{VR} - \frac{1}{VR}$$

$$\rho^2 = 1 - \frac{1}{VR}$$

Therefore,

$$\rho^2 = VD = 1 - \frac{1}{VR} \tag{3.27}$$

where ρ^2 is simply the coefficient of determination obtained from the regression equation.

From the above equations, if we assume that the correlation coefficient ρ is equal to zero, the VR will equal 1 and therefore the VD will equal zero. On the other hand, if we assume that the correlation coefficient is equal to 1, the variance correlation will equal infinity, and therefore the variance reduction will equal 1, that is, a perfect hedge.

3.11 Conclusion

In this chapter, we showed how the decision on hedging is a speculative decision and we explored different points of view regarding the hedging decision. We showed how whenever international-parity conditions hold, firms do not need to worry about foreign-exchange risk. We showed that there are different types of hedging techniques that firms could use to manage their transaction exposure. These techniques are divided into financial (internal) and operational (external) hedging techniques. In addition, we surveyed the literature, and we showed how different types of foreign-exchange exposure (such as transaction exposure, economic exposure, and translation exposure) are managed using the previously mentioned techniques. At the end of this chapter, we discussed the mathematics behind hedge ratio and how it is linked to VR and VD. Thus, we can now proceed in the following chapters to use historical data to carry out the empirical tests.

CHAPTER FOUR

TO HEDGE OR NOT TO HEDGE

4.1 Introduction

In this chapter, we examine the performance of different hedging strategies for a domestic firm in the GCC that is exposed to foreign currencies, such as the GBP, CHF, and JPY. These strategies are always to hedge, to hedge or not to hedge, and always not to hedge. Our results show that, on average, there is no difference in performance and risk under these hedging strategies for all of the GCC currencies considered against foreign currencies. The chapter starts in Section 4.2 with a literature review related to the incentive to hedge, and we present the data and methodology in Section 4.3, where we formulate different hypotheses to be tested. The results and analysis of mean, standard deviation, and our hypotheses are included in Section 4.4. The conclusion of this chapter is in Section 4.5.

4.2 Literature Review

Hedging is an important task for firms that are exposed to foreign-exchange-rate risk and want to minimise the uncertainty associated with unexpected changes in the exchange rate. Corporate managers are becoming aware of the need to manage foreign-exchange risk from a strategic point of view, and to take into account the movement of the exchange rate and its effect on future cash flows in the long run (Dhani and Groves, 2001).

Many theoretical papers examine hedging and the incentive to hedge. In Chapter 3 we examined the motives for hedging, such as the agency problem and the conflict between shareholders' interest and senior claim-holders' interest; circumvention of the underinvestment problem related to expensive external financing when the company faces trouble (Bessembinder, 1991; Froot *et al.*, 1993); reduction in the expected cost of bankruptcy (cost of financial distress); reduction in the expected tax payments when the tax function is concave (Smith and Stulz, 1985); the information effect of hedging, whereby hedging sends a positive signal showing that the firm is capable of reducing extraneous noise (DeMarzo and Duffie, 1995); and risk-averse managers who determine the optimal hedging policy at the corporate level, in order to smooth the earnings of the firm and, at the same time, maximise managers' lifetime expected utility, without affecting their own income and (or) wealth (Stulz, 1984).

Unexpected changes in exchange rates have raised concerns among international business firms about hedging their positions to avoid adverse effects on their value. These concerns give rise to the topic of financial-risk management as one of the important tasks that should be conducted by multinational corporations (MNCs) (Rawls and Smithson, 1990). For a long time, investment banks have been offering firms engaged in international business new financial products to be used as hedging tools against adverse movements in exchange rates.

As stated in Chapter 1, fluctuations in exchange rates affect not only firms that operate in international markets, but also domestic firms that compete with other firms importing goods from abroad. In other words, even domestic firms with operations only in the local market are affected by exchange-rate fluctuations (Adler and Dumas, 1984). An example is given by Smith *et al.* (1989) who show that when the domestic currency appreciates, the net cash flow for a domestic firm declines, as consumers reduce their demand for goods from this firm and shift to buy goods from another firm whose domestic currency did not appreciate.

Three hypothetical hedging strategies are examined in this chapter. This is undertaken to find out if there is a need to hedge by evaluating the performance of the domestic-currency value of payables. The first strategy is always to hedge, whereby the agent hedges, regardless of the expected spot rate. A hedger who uses this strategy is assumed to have a risk-averse profile. Moosa (2003b) argues that if a firm has highly risk-averse profile, it will always hedge its position without any consideration of exchange-rate movement. Under this strategy, firms think that it is impossible to forecast the future spot rate. This strategy is explained by Ederington (1979), who argues that the hedger implicitly adopts the minimum-risk hedge-ratio strategy, or pure risk avoidance, as referred to by Working (1962), by constructing a portfolio containing both spot and forward securities. Given that this strategy ignores the expected return, it is consistent with the minimum-variance strategy. Cecchetti *et al.* (1988) state that an objective of risk minimisation that is established without considering the expected return is not optimal. For this strategy to become consistent with the mean-variance framework, one of these conditions should be satisfied: the agent should be infinitely risk-averse; or the futures contract should yield zero expected return (Chen *et al.,* 2003).

The results presented by Perold and Schulman (1988) show that due to the small effect of hedging on the expected return, and its large effect on volatility, the always-hedge strategy is an optimal strategy. Eun and Resnick (1994) find that hedging exchange-rate risk by forward contracts improves the performance of international (bond only, bond and equity, equity only) portfolios compared with unhedged portfolios with respect to the risk–return trade-off. Moreover, Eun and Resnick (1997) find that the passive hedging strategy—whereby the agent always hedges using a forward contract—outperforms the unhedged strategy for US investors, based on the improvement in the risk–return relationship. Morey and Simpson (2001) use the return-per-risk ratio and ex-post efficient frontiers to evaluate the relative performance of five hedging strategies. They find that hedging using a forward contract, especially when the forward rate has a large historical forward premium, outperforms other strategies, on average, in the long-term horizon. However, for the short-term horizon, they find that the selective strategy, on average, outperforms other strategies. Nevertheless, hedging is not always the superior strategy because it might worsen the situation, as in the case of Korean investors who invested in international equity and suffered great losses due to the failure of currency hedging during the global financial crisis (Suh, 2011). In addition, Froot (1993) shows that as the length of the hedge extends, the purpose of hedging in reducing the variance of the portfolio return is reversed to increase the variance. Therefore, Froot's study supports short-term-horizon hedging.

The second strategy is to hedge or not to hedge, in which the agent forecasts the future spot rate $E_t S_{t+n}$ and bases their hedging decision on their forecast. Moosa (2004b) states that even if a firm has a perfectly accurate forecast of the future spot rate $E_t S_{t+n}$ relative to the forward rate F_t, the decision on whether to hedge or not to hedge will yield similar results to always hedge, and always no hedge, on average. This is attributed to the unbiasedness efficiency hypothesis, which is valid in the long run. Working (1962) argued that when the decision on hedging becomes selective (that is, built on price expectations) the aim of hedging is not risk avoidance in its exact meaning, but the avoidance of loss. On the other hand, Moosa (2004b) argues that a strategy of forecasting the future spot rate and then comparing the expected spot rate relative to the forward rate aims not at minimising risk, but at maximising the utility of the agent where the utility function is based on risk and expected return. Chen *et al.* (2003) show that when the agent takes into account expected return and risk in their hedge decision, the strategy becomes consistent with the mean-variance framework. They add that for such a framework to be consistent with expected-utility maximisation, one of the following two conditions should be met: a quadratic utility function, or jointly normal returns. Eaker and Grant (1990) also find that the selective strategy outperforms the always-hedge strategy, which is based on using a forward contract in international-equity portfolios.

Mitra and Rinco (1996) find that from the perspective of Canadian investors, selective hedging outperforms other strategies (fully hedged and unhedged) by offering a higher mean return; but it fails to do so in terms of the standard deviations of return. In their study on the Euro exchange rate, Simpson and Dania (2006) find that the selective strategy outperforms other strategies. Moreover, Glen and Jorion (1993) find that such a selective strategy—or what they call the conditional hedging strategy, based on the forecast of the return on the forward contract—improves the performance of diversified portfolios of stocks and bonds.

The third strategy, which is always not to hedge, is based on the unbiasedness efficiency hypothesis, which is based on the assumption that market participants are risk-neutral and adopt rational expectations (Rivero and Park, 1992). It assumes that the spot rate in the future, when the contract is due, is equal to the forward rate on the same maturity. In other words, the forward rate is an unbiased estimator of the expected spot rate. Therefore, there is no need to hedge the position by forward contract, since the bid–ask spread in the forward market is wider than the bid–ask spread in the spot market; the same result, or better, could be obtained by leaving the exposure uncovered. However, leaving the position uncovered yields high risk in the short-run, as little evidence has been found to support this hypothesis (Moosa, 2010).

4.3 Data and Methodology

In this chapter, we use a sample of end-of-the-month data for the spot exchange rate and the one-month forward rate of the Kuwaiti dinar (KWD), Saudi riyal (SAR), Emirati dirham (AED), Bahraini dinar (BHD) and Qatari riyal (QAR) as base currencies against the US dollar (USD), British pound (GBP), Swiss franc (CHF), and Japanese yen (JPY). The data are obtained from Thomson Reuters' *DataStream* and the International Monetary Fund's *International Financial Statistics* CD-ROM for the period 1:2000 to 11:2011. We assign x to the base currency and y to the exposure currency and assume a domestic firm in the GCC with payables of 100 in the foreign currency (exposure currency y). Table 4.1 summarises the sample data period for each currency, depending on availability.

Table 4.1 Sample Data Periods for Each Currency against the CHF, GBP, and JPY

Base Currency (x)	Period (End of the Month)	Number of Observations
KWD	1:2000 - 11:2011	143
SAR	1:2000 - 11:2011	143
AED	5:2000 - 11:2011	139
QAR	3:2004 - 11:2011	93
BHD	3:2004 - 11:2011	93

Jong *et al.* (1997) use the alpha-t model, Sharpe ratio, and the minimum-variance model to measure the effectiveness of different hedging strategies for out-of-sample data. McCarthy (2002) employs a simulation approach to evaluate 10 hedging strategies, which suggests that the always-hedge strategy (using a foreign-exchange forward contract) yields superior performance to the others. Further, McCarthy (2003) examines the three hedging strategies using only the Sharpe ratio and the minimum-variance model. The hedging strategies in his paper are always hedge using the forward rate, never hedge, and selectively hedge based on the forecast of the future spot rate. McCarthy finds that for Australian exporters, it is better always to hedge the position, whereas for Singaporean and Japanese exporters, leaving the exposure unhedged yields better results.

In this chapter, we follow the approach in Moosa (2004b) by testing whether there is any difference in the performance of the domestic-currency value of payables, on average, by testing the equality of means and variances for each of the three pre-assumed strategies. Suppose that there is a domestic firm operating in the GCC with K of payables in foreign currency y that is due on $t + n$. For simplicity, the amount of foreign payables will be GBP 100, CHF 100, and JPY 100. We assume that the firm could select from three hedging strategies. The first is buying a forward contract F_{t+n}, so that the domestic-currency value of the payables will be KF_{t+n} (the always-hedge strategy). Under this strategy, the firm knows at time t the expected domestic-currency value of the payables that will be paid at time $t + n$.

The second strategy is to hedge or not to hedge, which is based on the forecast of the spot rate. Following this strategy, the company will forecast the spot rate at $t + n$ and compare it with the forward rate. If the forecast spot rate is greater than the forward rate, $E_t S_{t+n} > F_t$, the company will hedge the exposure by buying a forward contract, as the domestic-currency value of the payables in this case will be lower under the hedge position than under the unhedged position. Therefore, the domestic-currency value of the payables at $t + n$ will be $V_x = KF_t$. The opposite is true if the forecast spot rate is less than the forward rate, $E_t S_{t+n} < F_t$ the company will not hedge as the domestic-currency value of the payables under the no-hedge position is less than the value under the hedge position. Therefore, the domestic-currency value of the payables at $t + n$ will be $V_x = KS_{t+n}$. To calculate the gain or loss for this strategy, it is the difference between the forward and the spot rate multiplied by the amount of payables $K(S_{t+n} - F_t)$ under the hedge decision, and $K(F_t - S_{t+n})$ under the no-hedge decision.

We forecast the spot rate using the basic flexible-price monetary model, taking into account the money-supply differential, interest-rate differential, and industrial-production differential. In this model, the exchange rate is determined by the quantity theory of money and purchasing-power parity (Moosa, 2000b). In addition, this model is based on economic theory, unlike univariate models that ignore the effect of other economic variables. The equation of the model is as follows:

$$s(x/y) = \alpha_0 + \beta_1(m_x - m_y) + \beta_2(y_x - y_y) + \beta_3(i_x - i_y) + \varepsilon_t \tag{4.1}$$

where $s(x/y)$ is the natural log of the nominal spot exchange rate, m is the natural log of the money supply M2 for CHF and JPY, and M4 for GBP, all of which are seasonally adjusted; y is the natural log of industrial production (seasonally adjusted) and i is the one-month lending interest rate. Belk and Glaum (1990) find that firms in the United Kingdom link their hedging decision to their view on the future exchange rate. Dolde (1993) finds that the perception of exchange-rate movement can affect the hedging decision. In addition, Moosa (2003b) argues that forecasting is the first step in financial hedging, and what matters in this step is not absolute forecasting accuracy, but relative forecasting accuracy. In other words, forecasting the level of the spot rate relative to the certain exchange rate implied by the hedge $E_t(S_{t+1}) = \bar{F}_t$ is much more important than is absolute forecasting accuracy for the hedger $E_t(S_{t+1}) = S_{t+1}$.

The third strategy presumes that managers of the company believe in the unbiasedness efficiency hypothesis, which states that the spot rate in the future, when the contract is due, is equal to the forward rate of the same maturity. Therefore, the company will not hedge, as there is no need to worry about foreign-exchange risk (no-hedge strategy). In this case, the domestic-currency value of the payables at $t+n$ will be $V_x = KS_{t+n}$.

The hypotheses for testing the equality of means are as follows:

$$H_0: \mu(V_{AH}) = \mu(V_{HN}) \tag{4.2}$$

$$H_0: \mu(V_{AH}) = \mu(V_{NH}) \tag{4.3}$$

$$H_0: \mu(V_{HN}) = \mu(V_{NH}) \tag{4.4}$$

where $\mu(V_{AH})$ is the population mean of the domestic currency value of payables under the always hedge (AH), $\mu(V_{HN})$ is the population mean of the domestic-currency value of payables under the hedge or no hedge (HN), and $\mu(V_{NH})$ is the population mean of the domestic-currency value of payables under the no hedge (NH). And the test statistic is

$$t = \frac{\bar{x}_1 - \bar{x}_2}{\sqrt{\frac{s_1^2}{n_1} + \frac{s_2^2}{n_2}}} \tag{4.5}$$

where $\bar{x}_1$and $\bar{x}_2$ are sample means, s_1^2 and s_2^2 are sample variances, and $n_1$and n_2 are sample sizes. To test the equality of variances

$$H_0: \sigma^2(V_{AH}) = \sigma^2(V_{HN}) \tag{4.6}$$

$$H_0: \sigma^2(V_{AH}) = \sigma^2(V_{NH}) \tag{4.7}$$

$$H_0: \sigma^2(V_{HN}) = \sigma^2(V_{NH}) \tag{4.8}$$

where $\sigma^2(V_{AH})$ is the variance of the domestic-currency value of payables under the always hedge (AH), $\sigma^2(V_{HN})$ is the variance of the domestic-currency value of payables under the hedge or no hedge (HN), and $\sigma^2(V_{NH})$ is the variance of the domestic-currency value of payables under the no hedge (NH). The test statistic is

$$VR = \frac{\sigma^2(V_U)}{\sigma^2(V_H)} \geq F_\alpha(n-1, n-1) \tag{4.9}$$

where $\sigma^2(V_U)$ is the domestic currency value of payables under the unhedged position and $\sigma^2(V_H)$ is the domestic currency value of payables under the hedged position. n is the corresponding sample size.

4.4 Results and Analysis

Table 4.2 shows the descriptive statistics of the mean and standard deviation of the domestic-currency value of payables under the three hedging decisions. The results of tests for the equality of means and variances are illustrated in Table 4.3.

Table 4.2 Mean and Standard Deviation for 100 Units of Foreign Currency (FC)

FC \ DC	KWD	SAR	AED	QAR	BHD
GBP					
AH					
Mean	48.944	630.722	618.661	640.808	66.287
St. Dev.	4.721	71.178	70.484	64.7005	6.72
HN					
Mean	48.967	631.127	619.466	641.556	66.359
St. Dev.	4.815	72.674	71.788	65.749	6.822
NH					
Mean	48.977	631.167	619.496	640.319	66.059
St. Dev.	4.779	71.569	70.712	65.621	7.165
JPY					
AH					
Mean	0.276	3.556	3.483	3.63	0.377
St. Dev.	0.035	0.503	0.5	0.506	0.053
HN					
Mean	0.274	3.544	3.473	3.62	0.375
St. Dev.	0.033	0.508	0.505	0.51	0.052
NH					
Mean	0.274	3.549	3.477	3.625	0.375
St. Dev.	0.034	0.513	0.51	0.516	0.052

Table 4.2 (Continued)

FC \ DC	KWD	SAR	AED	QAR	BHD
CHF					
AH					
Mean	23.619	304.96	300.937	327.988	34.061
St. Dev.	3.917	59.109	57.162	42.14	4.423
HN					
Mean	23.574	305.174	301.17	328.096	33.936
St. Dev.	3.829	59.318	57.363	42.593	4.409
NH					
Mean	23.611	305.881	301.949	328.828	34.005
St. Dev.	3.84	59.551	57.452	42.827	4.431

The results of tests for the equality of means and variances (Table 4.3) show that there is no difference in the performance of different hedging strategies, as they fail to reject the null hypothesis at the 5% level of significance. With regard to the variance, the results show that risk under each strategy is the same and that no strategy outperforms the others. The results indicate that domestic firms do not have to worry about foreign-exchange risk. However, it should be noted that these results are valid only for long-run exposure, and on average. The results do not suggest that the decision not to hedge (NH) is the best strategy, because the firm might incur huge financial losses in one day due to domestic-currency depreciation (as in the case of payables) or domestic-currency appreciation (as in the case of receivables).

Table 4.3 Results of Hypothesis Testing

FC \ DC	KWD	SAR	AED	QAR	BHD
GBP					
$H_0: \mu(V_{AH}) = \mu(V_{HN})$	-0.041	-0.047	-0.094	-0.077	-0.073
$H_0: \mu(V_{AH}) = \mu(V_{NH})$	-0.059	-0.052	-0.098	0.05	0.223
$H_0: \mu(V_{HN}) = \mu(V_{NH})$	-0.017	-0.004	-0.003	-0.077	0.292
$H_0: \sigma^2(V_{AH}) = \sigma^2(V_{HN})$	1.040	1.04	1.03	1.03	1.03
$H_0: \sigma^2(V_{AH}) = \sigma^2(V_{NH})$	1.024	1.01	1.00	1.02	1.13
$H_0: \sigma^2(V_{HN}) = \sigma^2(V_{NH})$	1.015	1.031	1.03	1.003	1.10
JPY					
$H_0: \mu(V_{AH}) = \mu(V_{HN})$	0.458	0.196	0.173	0.128	0.276
$H_0: \mu(V_{AH}) = \mu(V_{NH})$	0.454	0.115	0.096	0.067	0.234
$H_0: \mu(V_{HN}) = \mu(V_{NH})$	0.0005	-0.079	-0.076	-0.059	-0.041
$H_0: \sigma^2(V_{AH}) = \sigma^2(V_{HN})$	1.096	1.02	1.01	1.01	1.046
$H_0: \sigma^2(V_{AH}) = \sigma^2(V_{NH})$	1.055	1.04	1.03	1.04	1.029
$H_0: \sigma^2(V_{HN}) = \sigma^2(V_{NH})$	1.039	1.01	1.01	1.02	1.01
CHF					
$H_0: \mu(V_{AH}) = \mu(V_{HN})$	0.096	-0.03	-0.033	-0.017	0.191
$H_0: \mu(V_{AH}) = \mu(V_{NH})$	0.016	-0.13	-0.146	-0.134	0.085
$H_0: \mu(V_{HN}) = \mu(V_{NH})$	-0.08	-0.10	-0.112	-0.116	-0.105
$H_0: \sigma^2(V_{AH}) = \sigma^2(V_{HN})$	1.046	1.00	1.00	1.02	1.006
$H_0: \sigma^2(V_{AH}) = \sigma^2(V_{NH})$	1.04	1.01	1.01	1.03	1.003
$H_0: \sigma^2(V_{HN}) = \sigma^2(V_{NH})$	1.005	1.00	1.00	1.01	1.009

* Significant at the 5% level

In terms of the strategy to hedge or not to hedge (HN), the results could be attributed to the model used in this study to forecast the spot rate. It is known that forecasting accuracy is not always perfect, as many errors are associated with it. However, according to Moosa (2004b), what matters for hedging is not absolute forecasting accuracy, but the accuracy of forecasting for the spot rate relative to the forward rate.

With regard to the comparison of the strategy of always to hedge (AH) with the strategy of always not to hedge (NH), the results might be attributed to the validity of the unbiasedness efficiency hypothesis in the long run, due to the randomness of the error term, which means that positive errors cancel negative errors (Moosa, 2004b). In addition, it might be attributed to the instrument used for hedging. For example, if we use another hedging instrument, such as an options hedge, the results may or may not change. However, agents should consider the benefits and costs of each hedging instrument when undertaking a hedging strategy.

4.5 Conclusion

In this chapter, we surveyed the literature related to the agency problem; circumvention of the underinvestment problem; expected cost of bankruptcy; expected tax payments; information effect, and risk-averse managers and how they affect the incentive of hedging .We examined the performance of different hedging strategies for a domestic firm in the GCC that is exposed to foreign currencies, such as the GBP, CHF and JPY. These strategies are always to hedge, to hedge or not to hedge, and always not to hedge. The results showed that, on average, there is no difference in performance and risk under these three hedging strategies. The results also show that in terms of risk, no strategy outperforms the other. Hypothesis-testing results suggest that firms do not have to worry about foreign-exchange risk, at least in the long run. Different reasons were suggested to verify such results.

CHAPTER FIVE

THE EFFECTIVENESS OF HEDGING: A COMPARISON OF THREE FINANCIAL-HEDGING TECHNIQUES

5.1 Introduction

In this chapter, we examine the effectiveness of three financial-hedging techniques—forward hedging, money-market hedging and cross-currency hedging. We do this for a domestic firm in the GCC with foreign-currency exposure to GBP, CHF, and JPY. Our results show that there is no difference between using forward hedging or money-market hedging, due to the high correlation between spot and forward rates. However, in relation to cross-currency hedging, the results are mixed: the effectiveness of cross-currency hedging depends on exchange-rate correlation. This chapter starts with a literature review in Section 5.2 and presents data and methodology in Section 5.3, the results and analysis are in Section 5.4, and the conclusion is in Section 5.5.

5.2 Literature Review

Firms that are exposed to exchange-rate volatility and want to minimise the uncertainty associated with unexpected exchange-rate fluctuations can use financial-hedging techniques to hedge their position. Marshall (2000) states that due to the lack of a comprehensive framework for foreign-exchange risk management, firms tend to use different methods to manage their foreign-exchange exposure. This framework can be found in Froot *et al.* (1994) who propose guidelines for managers dealing with financial risk. They suggest that (i) it is not compulsory for firms working in the same industry to implement identical hedging strategies; (ii) risk management could be valuable for firms, even if they do not have broad investments in equipment and plant; (iii) firms with a conservative capital structure could gain from hedging, even if they have an excessive amount of cash and zero debt in their capital structure; (iv) investment opportunities could be affected by foreign-exchange risk in addition to cash flows; (v) knowing the hedging strategy of competitors is an important issue; and (vi) selecting a particular financial-hedging instrument should not just be the job of experts, as managers should also know the reason behind the selection of this instrument. Hakkarainen *et al.* (1998) show that the majority of firms use internal-hedging techniques to hedge their transaction and translation exposures, while they use external-hedging techniques to manage their economic exposure. Among financial-hedging techniques that were discussed in Chapter 3, the forward contract is the most widely used tool by managers because of its simplicity, low cost, and lack of any financial obligation at initiation (Khoury and Chan, 1988). Marshall (2000) shows that a forward contract is a widely used instrument as an external-hedging tool for transaction and translation exposure. El-Masry (2003) also finds that a forward contract is the most frequently used instrument in managing foreign-exchange exposure among non-financial firms in the United Kingdom.

As stated in Chapter 3, when $F=\bar{F}$, then CIP holds and there is no difference between hedging by forward contract and hedging by money-market hedge. They will produce similar results, as Al-Loughani and Moosa (2000) find when they test the effectiveness of forward hedging versus money-market hedging by examining whether the CIP holds or not indirectly. They find that the CIP does hold and these two hedging techniques are equivalent to each other, as both of them reduce the variability of the return.

Jesswein *et al.* (1995) survey Fortune US 500 MNCs and find that about 93.1 per cent use forward contracts, 52.6 per cent use foreign-currency swaps, and 48.8 per cent use over-the-counter (OTC) options; this implies that the majority of these firms use financial contracts to hedge their exposure. In their study on foreign-exchange exposure in New Zealand, Naylor and Greenwood (2006) find that the most widely used instrument to hedge foreign-exchange exposure is the forward contract, followed by OTC simple options, and swaps.

Bodnar *et al.* (1995) find that the main instrument used to hedge foreign-exchange exposure is forward contracts, followed by swaps, and options, respectively. In their more specific survey, Bodnar *et al.* (1996) find that among four types of financial risks (equities, interest rates, commodities price, and foreign exchange), the use of foreign-exchange derivatives dominates the use of other derivatives. Further, they find that the main instrument used to hedge foreign-exchange-rate exposure is forward contracts, followed by options and swaps, respectively.

Bodnar *et al.* (1998) point out why some of the firms do not use derivatives in hedging because these firms have only a low level of exposure and they think that the cost of derivative use exceeds its benefits; they manage their exposure using operational techniques, such as diversification, currency collars, or risk-sharing arrangements. Vij (2009) finds that forward contracts are the most widely used instrument among Indian firms. According to Charumathi and Kota (2012), investigating the determinants of derivative use, the size of the firm is the key factor for non-financial Indian firms. Pramborg (2005) finds that Korean and Swedish firms place greater emphasis on forward contracts as a hedging tool. Chong *et al.* (2014) find that the majority of non-financial firms working in Malaysia use financial hedging to hedge their foreign-exchange-rate risk.

According to Benet (1990) and Eaker and Grant (1987), cross-currency hedging can be used when there are no futures or forward contracts for minor currencies. To ensure the effectiveness of cross-currency hedging, the firm should pay considerable attention to the correlation requirement of about 0.50, because low correlations are not conducive to effective hedging (Moosa, 2003b; Moosa, 2006a). Moosa (2001) finds that it does not matter whether hedging is conducted using a cross forward, forward contract, or no-hedging decision, as all of these tools yield the same result.[8] However, this does not mean that hedging is an inappropriate decision, because his finding is only valid on average, and in the long-run. Graff *et al.* (1997) show that cross-currency hedging can also be used for agricultural commodities, which lack an active futures market.

Moosa (2003c) shows that forward and money-market hedging techniques are much more effective than cross-currency hedging. The reason behind this is that the correlation coefficient between the exchange rates is very low. Moosa (2006a) confirms this result using the Kuwaiti dinar as the base currency.

5.3 Data and Methodology

The data in this chapter are the same as we used in Chapter 4, except that the periods of the sample and the number of observations for QAR and BHD are different. Table 5.1 summarises the sample data period for each currency, depending on availability.

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[8] Cross forward is the use of forward position on a third currency $f(x/z)$

Table 5.1 Sample Data Period for Each Currency against the CHF, GBP, and JPY

Base Currency (x)	Period (End of the Month)	Number of Observations
KWD	1:2000 - 11:2011	143
SAR	1:2000 - 11:2011	143
AED	5:2000 - 11:2011	139
QAR	7:2004 - 11:2011	89
BHD	12:2006 -11:2011	60

To examine the effectiveness of cross-currency hedging versus forward hedging and money-market hedging, first of all, using Equation (3.19), we need to estimate the optimal hedge ratio to calculate the correlation rate that makes cross-currency hedging as effective as forward hedging and money-market hedging. Stulz (2003) states that the returns in the spot price and the returns in the hedging instrument are each independently identically distributed, and there is a constant linear relationship between the hedging-instrument-price return and the spot-price return that does not change over time (joint distribution). According to Moosa (2003a) and Moosa (2011a), the effectiveness of futures versus money-market hedging, and the effectiveness of cross-currency hedging versus money-market hedging do not depend on the sophistication of the econometric model, as they will all produce similar results.

Second, as in Moosa (2003c), after estimating the optimal hedge ratio above, we calculate the rate of return under each of the four positions R_U, R_F, R_M, and R_M

$$R_U = 100[\Delta s\,(x/y)] \tag{5.2}$$

$$R_F = 100[\Delta s\,(x/y) - h_F \Delta f\,(x/y)] \tag{5.3}$$

$$R_M = 100[\Delta s\,(x/y) - h_M \Delta \bar{f}\,(x/y)] \tag{5.4}$$

$$R_C = 100[\Delta s\,(x/y) - h_C \Delta s\,(x/z)] \tag{5.5}$$

where R_U is the rate of return under the no-hedge decision and R_F, R_M, and R_C are the rate of return under the forward, money-market, and cross-currency hedge, respectively.

Third, we examine the effectiveness of the no-hedge decision against the hedge decision (forward, cross, money-market hedge) by testing the equality of variances for the returns under each position.

$$H_0: \sigma^2(R_U) = \sigma^2(R_H) \tag{5.6}$$

$$H_a: \sigma^2(R_U) > \sigma^2(R_H) \tag{5.7}$$

where $\sigma^2(R_U)$ is the variance rate of the return under the no-hedge decision and $\sigma^2(R_H)$ is the variance of the rate of return under the hedge decision (forward, cross, money-market hedge). The test statistic is

$$VR = \frac{\sigma^2(R_U)}{\sigma^2(R_H)} \geq F_\alpha(n-1, n-1) \tag{5.8}$$

which will be accompanied by the variance reduction

$$VD = 100\left[1 - \frac{\sigma^2(R_H)}{\sigma^2(R_U)}\right] = 100\left[1 - \frac{1}{VR}\right] \tag{5.9}$$

5.4 Results and Analysis

Tables 5.2 to 5.4 and Figures 5.1 to 5.4 show how hedging effectiveness is related to the correlation coefficient, hedge ratio, VR, and VD at the 5% level of significance.

Table 5.2 Forward Hedging of GCC Currencies against Foreign Currency (FC)

x	y	ρ	h	$\sigma^2(R_U)$ x10^5	$\sigma^2(R_H)$ x10^5	VR	VD (%)
KWD	CHF	0.997	0.993*	87.416	28.800	3.03*	67.05
KWD	GBP	0.999	1.007*	56.238	0.0825	680.86*	99.85
KWD	JPY	0.992	0.970*	69.610	31.183	2.23*	55.20
SAR	CHF	0.999	1.001*	112.835	0.028	4012.88*	99.97
SAR	GBP	0.999	1.004*	69.370	0.031	2234.8*	99.95
SAR	JPY	0.998	0.996*	70.049	9.559	7.32*	86.35

Table 5.2 (Continued)

x	y	ρ	h	$\sigma^2(R_U)$ x10^5	$\sigma^2(R_H)$ x10^5	VR	VD (%)
AED	CHF	0.999	1.001*	114.631	0.031	3668.31*	99.97
AED	GBP	0.999	1.005*	68.922	0.039	1734.13*	99.94
AED	JPY	0.999	0.995*	71.092	7.450	9.54*	89.52
QAR	CHF	0.999	1.005*	132.874	0.038	3485.81*	99.97
QAR	GBP	0.999	1.008*	79.730	0.067	1184.54*	99.91
QAR	JPY	0.999	0.997*	69.971	7.106	9.84*	89.84
BHD	CHF	0.999	1.001*	165.836	0.202	820.81*	99.87
BHD	GBP	0.999	1.006*	93.980	0.106	884.74*	99.88
BHD	JPY	0.998	0.997*	90.305	0.208	433.14*	99.76

* Significant at the 5% level

Table 5.3 Money-Market Hedging of the GCC Currencies against Foreign Currency

x	y	ρ	h	$\sigma^2(R_U)$ x10^5	$\sigma^2(R_H)$ x10^5	VR	VD (%)
KWD	CHF	0.998	1.019*	87.416	1.222	71.51*	98.60
KWD	GBP	0.993	1.056*	56.238	1.456	38.60*	97.41
KWD	JPY	0.993	1.046*	69.610	1.312	53.03*	98.11
SAR	CHF	0.998	1.016*	112.835	0.777	145.06*	99.31
SAR	GBP	0.996	1.028*	69.370	0.685	101.23*	99.01
SAR	JPY	0.995	1.054*	70.049	0.704	99.47*	98.99
AED	CHF	0.998	0.992*	114.631	0.569	201.25*	99.50
AED	GBP	0.994	1.031*	68.922	0.683	100.76*	99.00
AED	JPY	0.996	1.018*	71.092	0.447	158.72*	99.37
QAR	CHF	0.997	1.038*	132.874	3.316	40.06*	97.50
QAR	GBP	0.993	1.092*	79.730	2.773	28.74*	96.52
QAR	JPY	0.998	1.049*	69.971	3.655	19.14*	94.77
BHD	CHF	0.999	1.025*	165.836	0.572	289.86*	99.65
BHD	GBP	0.998	1.061*	93.980	1.182	79.45*	98.74
BHD	JPY	0.997	1.002*	90.305	0.468	192.74*	98.99

* Significant at the 5% level

The results show that forward hedging (Table 5.2) and money-market hedging (Table 5.3) provide almost the same result for all of the currency combinations. Both forward hedging and money-market hedging provide an almost unity hedge ratio. The variance reduction is almost 100 per cent, except for KWD/CHF and KWD/JPY (in terms of forward hedging), with 67 and 55 per cent, respectively; for QAR/GBP and QAR/JPY (in terms of money-market hedging), with 96 and 94 per cent, respectively. This result is attributed to the high correlation between (i) the spot rate with the forward rate (for forward hedging); and (ii) the spot rate with the implicit forward rate calculated by interest-rate parity (for money-market hedging). In addition, this result suggests that the covered interest-rate parity is valid (Al-Loughani and Moosa, 2000). Moreover, given that the VR test is significant at the 5% significance level, both forward hedging and money-market hedging provide similar effectiveness in hedge results. Hence, the two techniques reduce the variance significantly.

Table 5.4 Cross-Currency Hedging of the GCC Currencies against Foreign Currency

x	y	z	ρ	h	$\sigma^2(R_U)$ x10^5	$\sigma^2(R_H)$ x10^5	VR	VD (%)
KWD	CHF	JPY	0.259	0.291*	87.416	81.510	1.07	6.75
KWD	CHF	GBP	0.315	0.356*	87.416	78.726	1.11	9.94
KWD	GBP	JPY	0.000	-0.020	56.238	56.238	1	0.00
KWD	GBP	CHF	0.403	0.324*	56.238	47.081	1.19	15.97
KWD	JPY	CHF	0.259	0.232*	69.610	64.907	1.07	6.75
KWD	JPY	GBP	0.000	0.000	69.610	69.610	1	0.00
SAR	CHF	JPY	0.342	0.435*	112.835	99.565	1.13	11.76
SAR	CHF	GBP	0.529	0.675*	112.835	81.195	1.39*	28.04
SAR	GBP	JPY	0.083	0.082	69.370	68.891	1.00	0.69
SAR	GBP	CHF	0.529	0.415*	69.370	49.918	1.38*	28.04
SAR	JPY	CHF	0.342	0.270*	70.049	61.811	1.13	11.76
SAR	JPY	GBP	0.083	0.083	70.049	69.565	1.00	0.69
AED	CHF	JPY	0.346	0.440*	114.631	100.851	1.13	12.02
AED	CHF	GBP	0.535	0.690*	114.631	81.758	1.40*	28.67
AED	GBP	JPY	0.077	0.076	68.922	68.504	1.00	0.60
AED	GBP	CHF	0.535	0.415*	68.922	49.158	1.40*	28.67
AED	JPY	CHF	0.346	0.273*	71.092	62.546	1.13	12.02
AED	JPY	GBP	0.077	0.079	71.092	70.660	1.00	0.60

Table 5.4 (Continued)

x	y	z	ρ	h	$\sigma^2(R_U)$ x10^5	$\sigma^2(R_H)$ x10^5	VR	VD (%)
QAR	CHF	JPY	0.359	0.495*	132.874	115.739	1.14	12.89
QAR	CHF	GBP	0.482	0.622*	132.874	101.993	1.30	23.24
QAR	GBP	JPY	0.032	0.035	79.730	79.646	1.00	0.10
QAR	GBP	CHF	0.482	0.373*	79.730	61.200	1.30	23.24
QAR	JPY	CHF	0.345	0.071*	69.971	61.627	1.13	11.92
QAR	JPY	GBP	0.032	0.030	69.971	69.897	1.00	0.10
BHD	CHF	JPY	0.321	0.436*	165.836	148.658	1.11	10.35
BHD	CHF	GBP	0.399	0.530*	165.836	139.352	1.19	15.96
BHD	GBP	JPY	0.117	-0.120	93.980	92.673	1.01	1.39
BHD	GBP	CHF	0.399	0.300*	93.980	78.972	1.19	15.96
BHD	JPY	CHF	0.229	0.135	58.054	55.005	1.05	5.25
BHD	JPY	GBP	0.196	-0.154	58.054	55.805	1.04	3.87

* Significant at the 5% level

In terms of cross-currency hedging (Table 5.4), the result is mixed because of the different correlations between the exposure-currency exchange rate $\Delta s(x/y)$ and the third-currency exchange rate $\Delta s(x/z)$. For all currency combinations, cross-currency hedging does not provide an effective hedge except in some combinations of the Saudi riyal and Emirati dirham. For example from the Saudi firms' perspective, hedging CHF exposure with the GBP, and hedging GBP exposure with the CHF provide an effective hedge, as the variance is reduced by 28.04 per cent as shown in Table 5.4. Table 5.4 also shows the case from the perspective of Emirati firms, hedging CHF exposure with the GBP, and hedging GBP exposure with the CHF provide an effective hedge, as the variance is reduced by 28.67 per cent. Although there are significant relationships between $\Delta s(x/y)$ and $\Delta s(x/z)$ in some currency combinations, none of the cross-currencies provide significant VD (except the ones mentioned above). It is noteworthy that when we examine the graphs of the hedge ratio as a function of the correlation coefficient in Figure 5.1, the hedge ratio is not identical to the correlation coefficient. This is because $\sigma(R_U) \neq \sigma(R_A) \neq 1$.[9] Figures 5.1 to 5.4 show the relationship between correlation and hedge ratio, VR and VD.

5.5 Conclusion

In this chapter, we examined the effectiveness of three financial-hedging techniques—forward hedging, money-market hedging and cross-currency hedging—for a domestic firm in the GCC with foreign-currency exposure to the GBP, CHF, and JPY. The results show that there is no difference between using forward hedging and using money-market hedging, as there is a high correlation between the spot and the forward rates. However, in relation to cross-currency hedging, the results are mixed. It shows that to be effective in hedging, there should be a high correlation between the exposure-currency exchange rate and the third-currency exchange rate.

[9]The mathematical proof of this relationship was discussed in Chapter 3.

Figure 5.1 Hedge Ratio as a Function of Correlation

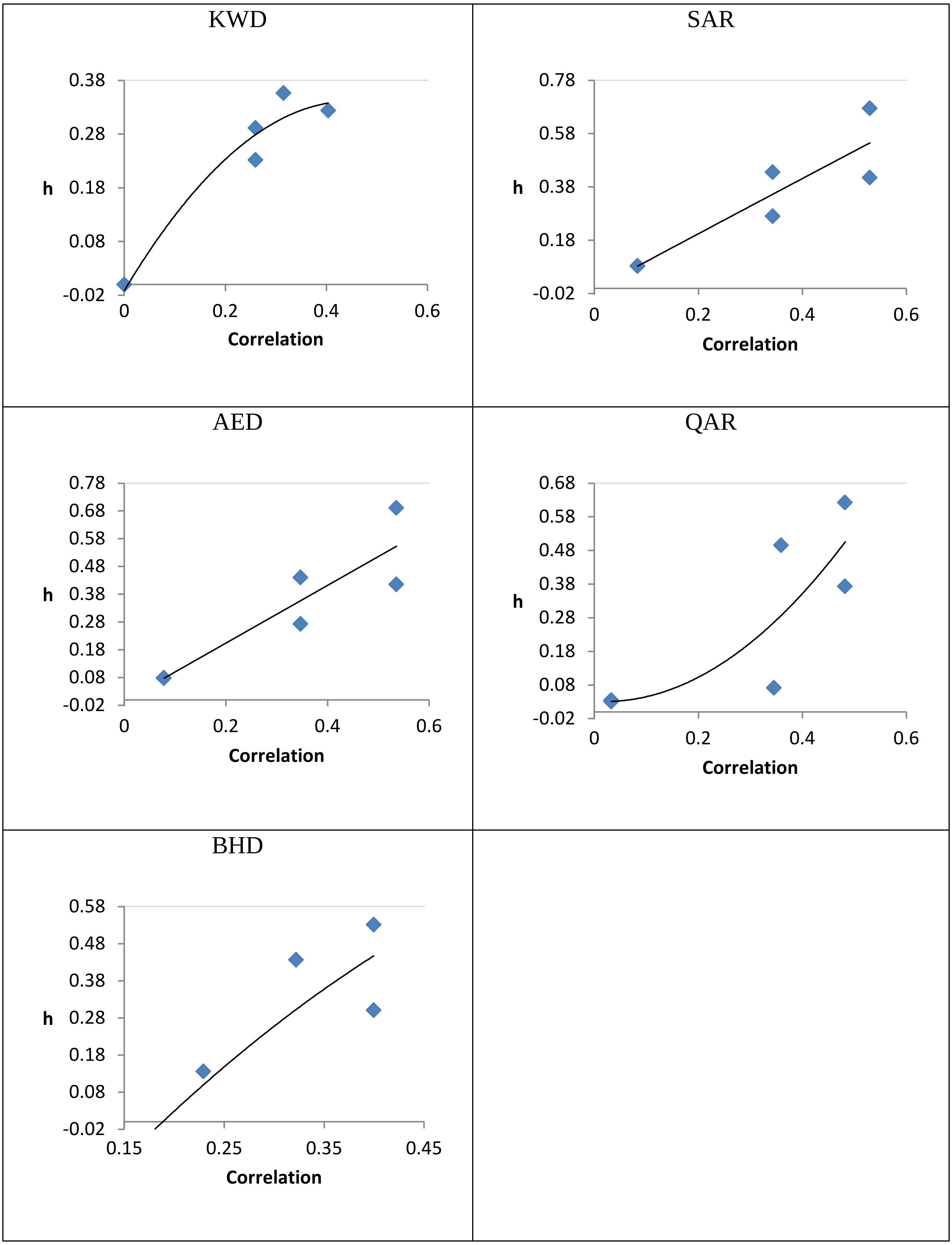


Figure 5.2 Variance Ratio as a Function of Correlation

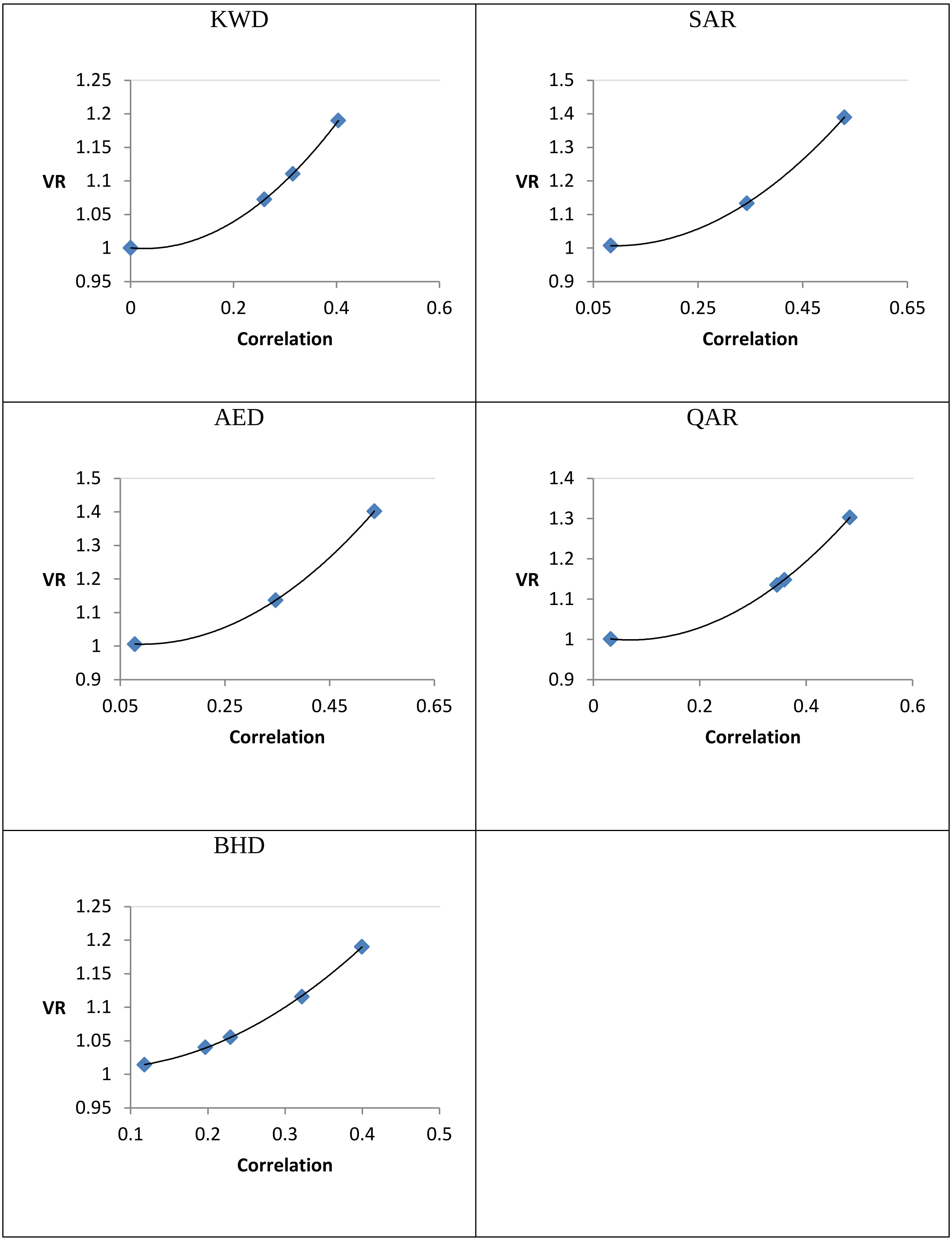


Figure 5.3 Variance Reduction as a Function of Correlation

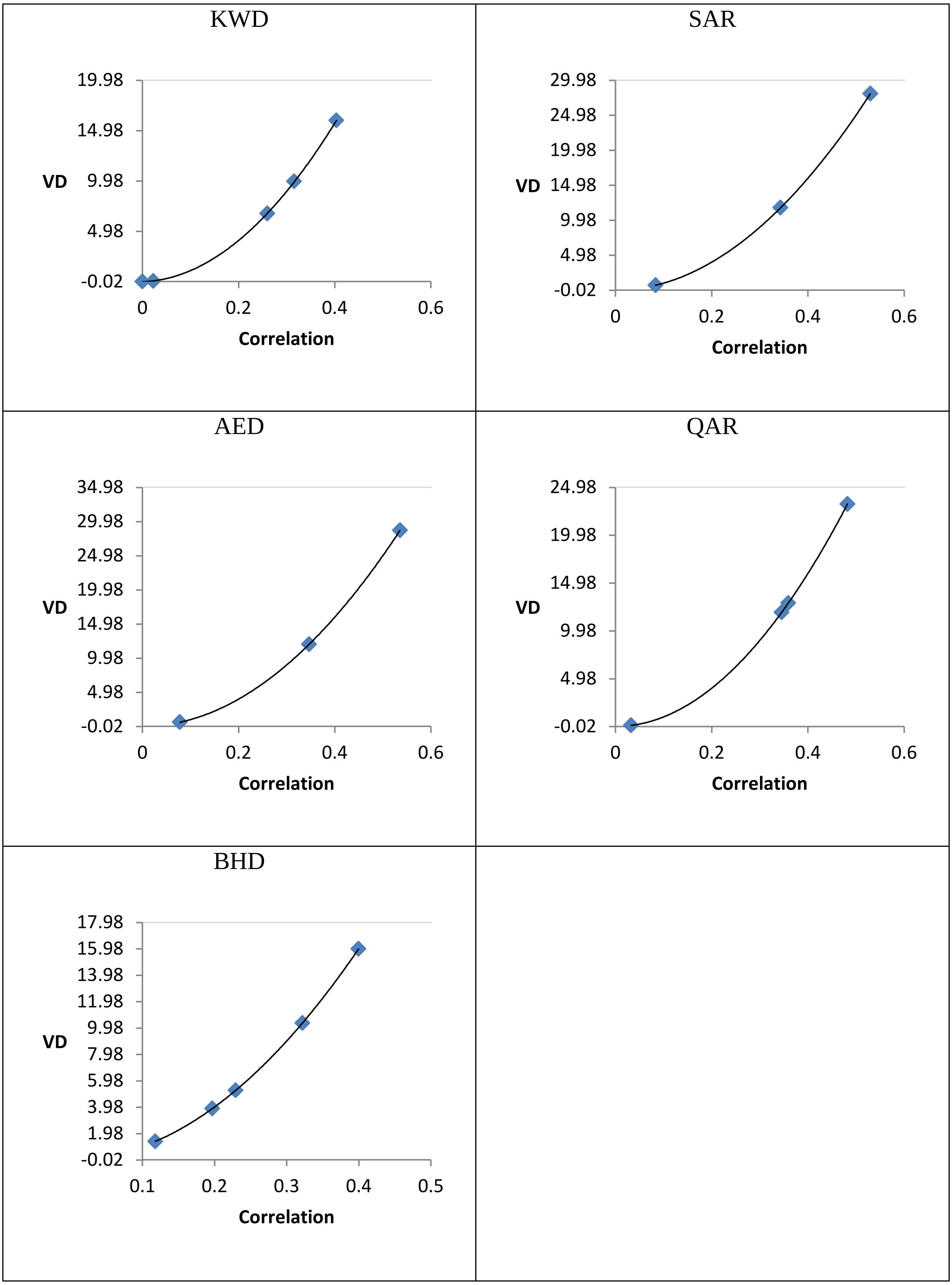
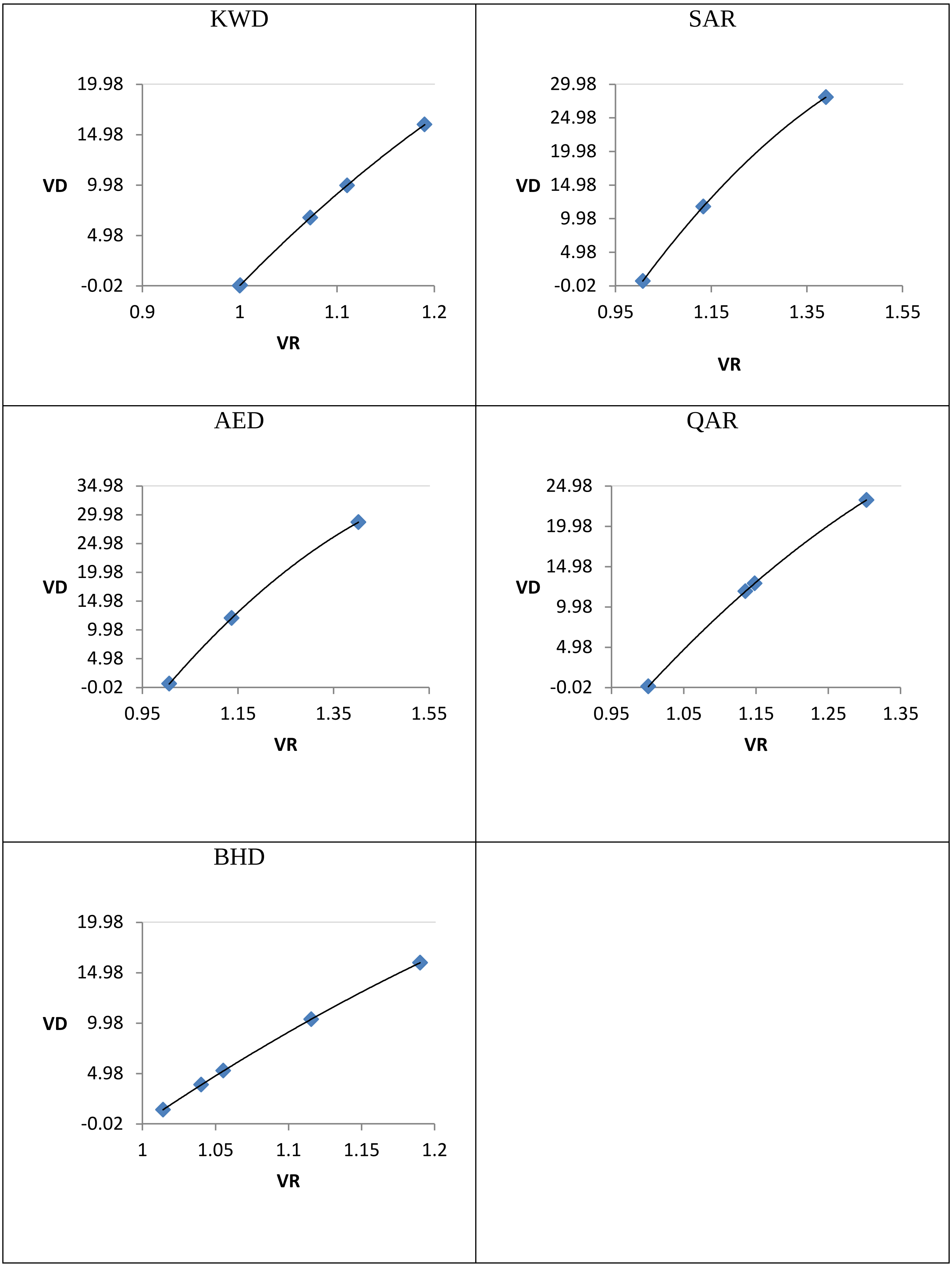


Figure 5.4 Variance Reduction as a Function of Variance Ratio



CHAPTER SIX

THE COMPARATIVE EFFECTIVENESS OF FINANCIAL AND OPERATIONAL HEDGING

6.1 Introduction

In this chapter, we examine the effectiveness of financial-hedging techniques—such as forward hedging—versus operational-hedging techniques, such as risk-sharing arrangements, currency collars and hybrid arrangements for a domestic firm in the GCC with foreign-currency exposure to the GBP, CHF, and JPY. Our results show that forward hedging is more effective than either risk-sharing arrangements or hybrid arrangements. However, when compared with currency collars, the results are mixed. Moreover, we find that hybrid-arrangements hedging consisting of a 0.667 weight of risk-sharing arrangements represents the optimum weight at which the maximum value of the domestic-currency value of payables, the variance of domestic-currency value of payables, the variance ratio, and variance reduction become insensitive to changes in risk parameters. This chapter starts with a literature review in Section 6.2 and proceeds with the data and methodology in Section 6.3. The results and analysis are in Section 6.4, and the conclusion is in Section 6.5.

6.2 Literature Review

We mentioned in Chapter 3 that two techniques are used to hedge transaction exposure: (i) financial-hedging (external) techniques, such as forwards, futures, options, currency swaps, money-market hedging, and cross-currency hedging; and (ii) operational-hedging (internal) techniques, such as leading and lagging, currency diversification, exposure netting, price variation and currency of invoicing, risk-sharing arrangements, currency collars, and a hybrid arrangement. The literature contains many studies covering the use of financial instruments to hedge exposure to foreign-exchange risk, whereas studies of operational hedging are few and limited, despite the importance of minimising foreign-exchange risk. For example Hommel (2003) argues that operational hedging can be used as a strategic complementary tool, as well as financial hedging, as it improves the minimisation of the variance. He further states that operational flexibility can also add value to the firm, as it reduces the effective cost of production and puts a limit on the downside-performance risk. On the other hand, Huston and Laing (2014) find that financial hedging and operational hedging can be used as complements only in the absence of stressed situations, whereas during tough periods (such as the global financial crisis) operational hedging can be used as a substitute for financial hedging. This is because of its effectiveness in dealing with highly volatile exchange rates. This argument is supported by Dong *et al.* (2014), who find that operational hedging can minimise downside risk with a highly volatile exchange rate, as well as increasing the firm's expected profit. Bradley and Moles (2002) find that operational hedging is extensively used by publicly listed UK non-financial firms. Davies *et al.* (2006) find that internal-hedging instruments are used more by Norwegian exporting firms than external-hedging instruments. Pantzalis *et al.* (2001) find that MNCs with a greater breadth (the number of countries across which MNCs' subsidiaries are scattered) face lower foreign-exchange risk, whereas MNCs with greater depth (MNCs' subsidiaries concentrated in a small number of countries) will experience higher foreign-exchange risk.

Joseph (2000) shows that firms in the United Kingdom pay greater attention to the use of currency derivatives (external-hedging techniques) than to internal-hedging techniques, whereas Marshall (2000) shows that a large number of firms in the United States, the United Kingdom, and Asia use both internal and external methods; only a few of them do not use hedging instruments. In addition, in exploring the use of internal and external methods with respect to each type of exposure, Marshall finds that with respect to transaction exposure, the majority of firms use netting followed by matching as the most popular internal-hedging methods; forward contracts followed by options are the widely used instruments of the external-hedging method. McDonald and Moosa (2003) find that both risk-sharing arrangements and currency collars are as effective as forward contracts, especially when the exchange rates of RS and CC become very close to the upper and lower values (very wide neutral zone). Moosa and McDonald (2005) show that operational-hedging techniques (such as risk-sharing arrangements and currency collars) are as effective as financial-hedging techniques (such as forward contracts). Using a Nash-equilibrium simulation model for the CAD and GBP, Moosa and Lien (2004) find that if one of the firms is more risk-averse than the other, both parties will benefit from hedging. In addition, they find that at a certain level of risk aversion, the risk-sharing-threshold parameter has a positive relationship with the standard deviation of the exchange rate.

In his study on the USD and CAD, Moosa (2006b) finds that the hybrid operational technique with a weight of 0.664 allocated to risk-sharing arrangements can totally eliminate the sensitivity of cash flows to the value of the parameters. In addition, Moosa (2011b) finds that allocating weights of two-thirds to risk-sharing arrangements and one-third to currency collars can effectively eliminate the sensitivity of cash flows to the value of the risk parameters.

6.3 Data and Methodology

We use the same data as in Chapter 4, except that the period of the sample and the number of observations for BHD are different. We assume different values of the changing risk parameter θ in this example such as 0.001, 0.002, 0.004, 0.006, 0.008, and 0.01.[10] $\bar{S}$ represents the sample mean of the spot rates for the covered period. Table 6.1 summarises the sample-data period for each currency, depending on availability.

Table 6.1 Sample Data Period for Each Currency against the CHF, GBP, and JPY

Base Currency (x)	Period (End of the Month)	Number of Observations
KWD	1:2000 - 11:2011	143
SAR	1:2000 - 11:2011	143
AED	5:2000 - 11:2011	139
QAR	7:2004 - 11:2011	89
BHD	3:2004 - 11:2011	93

We test the effectiveness of operational hedging against that of financial hedging based on the equations of risk-sharing arrangements and currency collars as stated in Chapter 3. To be more specific, we test the effectiveness of forward hedging, risk-sharing arrangements, currency collars, and hybrid-arrangement techniques.

To test the variability of the domestic-currency cash flows under no hedge against the variability of the domestic-currency value of payables under operational hedging (such as risk-sharing arrangements, currency collars, and hybrid arrangements):

$$H_0: \sigma^2(V_U) = \sigma^2(V_{RS}) \quad (6.1)$$

$$H_0: \sigma^2(V_U) = \sigma^2(V_{CC}) \quad (6.2)$$

$$H_0: \sigma^2(V_U) = \sigma^2(V_{HY}) \quad (6.3)$$

where $\sigma^2(V_U)$ is the variance of the domestic-currency value of payables under the no hedge, whereas $\sigma^2(V_{RS})$, $\sigma^2(V_{CC})$, and $\sigma^2(V_{HY})$ are the variance of the domestic-currency value of

[10] The choice of these values is arbitrary.

payables under risk-sharing arrangements, currency collars, and hybrid arrangements, respectively.

To test the variability of the domestic-currency value of payables under no hedge against the variability of the domestic-currency value of payables under financial hedging (forward contract):

$$H_0: \sigma^2(V_U) = \sigma^2(V_F) \tag{6.4}$$

where $\sigma^2(V_F)$ is the variance of the domestic-currency value of payables under the forward hedge.

To test the variability of the domestic-currency value of payables under forward contracts against the variability of the domestic-currency value of payables under risk-sharing arrangements, currency collars, and hybrid arrangements (equal weights) given different sets of parameters values θ:

$$H_0: \sigma^2(V_{RS}) = \sigma^2(V_F) \tag{6.5}$$

$$H_0: \sigma^2(V_{CC}) = \sigma^2(V_F) \tag{6.6}$$

$$H_0: \sigma^2(V_{HY}) = \sigma^2(V_F) \tag{6.7}$$

Similarly to McDonald and Moosa (2003), we investigate which hedging tool is more effective in minimising the variability of domestic-currency cash flows under the hedge and the no-hedge decision using the variance ratio as in Equation (4.9) and accompanied with variance reduction

$$VD = 100\left[1 - \frac{\sigma^2(V_H)}{\sigma^2(V_U)}\right] = 100\left[1 - \frac{1}{VR}\right] \tag{6.8}$$

In addition, we determine whether the hybrid arrangement—based on the weighted average of the two exchange rates under risk-sharing arrangements—and currency collars—that are used to convert foreign payables into the domestic-currency value—can reduce the sensitivity of the cash flows to the value of the parameters. We also find the optimum weight of risk-sharing arrangement β in which the domestic-currency value of payables under the hybrid arrangement becomes insensitive to the change in risk parameter θ, as in Equations (3.3), (3.4), and (3.5). This will be accomplished by studying the effect of the risk parameter on the maximum value of the payables in the domestic currency V_x (Max), the variance of the payables in the domestic currency $Var.(V_x)$, the variance ratio (VR), and the variance reduction (VD).

6.4 Results and Analysis

Tables 6.2 to 6.6 show the empirical results of the VR and VD for all of the seven hypotheses that test the effectiveness of financial hedging versus operational hedging. Regarding RS, when compared with the unhedged decision, the results show that the VR is significant at the 5% level of significance for all of the currency combinations. This result is valid for all of the given risk parameters, which range from 0.001 to 0.01. Tables 6.7 to 6.11 show V_x *(Max)*, $Var.(V_x)$, the VR and the VD of RS, CC, and HY (equal weights β=0.50) for all of the currency combinations under different risk parameters θ. The tables show that as θ increases, V_x *(Max)* under RS decreases. In addition, as θ increases, $Var.(V_x)$ decreases under RS. The results also show that for RS, the effectiveness of the hedge represented by the VD is positively related to the value of the risk parameter—that is, as θ increases, the VD increases consequently (see Tables 6.7 to 6.11 and Figures 6.1 to 6.3). Linking this relationship to Chapter 3, in which the discussion on RS took place, this suggests that we have a wider range for converting cash flows at the fixed rate $\bar{S}$ (the neutral zone).

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Table 6.2 Results of Hypothesis Testing of KWD

	$H_0: \sigma^2(V_U) = \sigma^2(V_{RS})$		$H_0: \sigma^2(V_U) = \sigma^2(V_{CC})$		$H_0: \sigma^2(V_U) = \sigma^2(V_{HY})$		$H_0: \sigma^2(V_U) = \sigma^2(V_F)$		$H_0: \sigma^2(V_{RS}) = \sigma^2(V_F)$		$H_0: \sigma^2(V_{CC}) = \sigma^2(V_F)$		$H_0: \sigma^2(V_{HY}) = \sigma^2(V_F)$	
	VR	VD (%)	VR	VD (%)	VR	VD (%)	VR	VD (%)	VR	VD (%)	VR	VD (%)	VR	VD (%)
θ= 0.001														
KWD/GBP	4.037*	75.233	9621.168*	99.990	15.569*	93.577	3614.064*	99.972	895.080*	99.888	[2.662]*	62.436	232.119*	99.569
KWD/JPY	3.889*	74.291	15430.155*	99.994	15.153*	93.400	52.799*	98.106	13.573*	92.632	[292.238]*	99.657	3.484*	71.300
KWD/CHF	3.982*	74.888	26552.287*	99.996	15.632*	93.603	180.764*	99.447	45.392*	97.797	[146.888]*	99.319	343.154*	99.708
θ= 0.002														
KWD/GBP	4.113*	75.687	2416.239*	99.959	15.290*	93.459	3614.064*	99.972	878.663*	99.886	1.495*	33.143	236.364*	99.576
KWD/JPY	3.941*	74.631	3870.041*	99.974	14.955*	93.313	52.799*	98.106	13.394*	92.534	[73.296]*	98.635	3.53*	71.674
KWD/CHF	4.019*	75.123	6713.739*	99.985	15.487*	93.543	180.764*	99.447	44.968*	97.776	[37.140]*	97.307	346.378*	99.711
θ= 0.004														
KWD/GBP	4.269*	76.580	607.836*	99.835	14.751*	93.221	3614.064*	99.972	846.387*	99.881	5.945*	83.181	244.989*	99.591
KWD/JPY	4.048*	75.300	976.077*	99.898	14.570*	93.136	52.799*	98.106	13.041*	92.332	[18.486]*	94.59	3.623*	72.404
KWD/CHF	4.096*	75.587	1719.957*	99.942	15.201*	93.421	180.764*	99.447	44.129*	97.733	[9.514]*	89.49	352.891*	99.716
θ= 0.006														
KWD/GBP	4.435*	77.453	273.011*	99.634	14.240*	92.977	3614.064*	99.972	814.846*	99.877	13.237*	92.445	253.786*	99.605
KWD/JPY	4.159*	75.956	439.154*	99.772	14.198*	92.957	52.799*	98.106	12.694*	92.122	[8.317]*	87.976	3.718*	73.108
KWD/CHF	4.174*	76.044	777.042*	99.871	14.922*	93.298	180.764*	99.447	43.303*	97.69	[4.298]*	76.736	359.491*	99.721
θ= 0.008														
KWD/GBP	4.609*	78.306	154.138*	99.351	13.753*	92.729	3614.064*	99.972	784.034*	99.872	23.446*	95.735	262.765*	99.619
KWD/JPY	4.273*	76.600	248.713*	99.598	13.839*	92.774	52.799*	98.106	12.354*	91.906	[4.710]*	78.770	3.815*	73.788
KWD/CHF	4.254*	76.494	443.646*	99.775	14.650*	93.174	180.764*	99.447	42.490*	97.646	[2.454]*	59.254	366.174*	99.726
θ= 0.01														
KWD/GBP	4.793*	79.138	98.814*	98.988	13.290*	92.475	3614.064*	99.972	753.951*	99.867	36.574*	97.265	271.926*	99.632
KWD/JPY	4.392*	77.232	160.199*	99.376	13.492*	92.588	52.799*	98.106	12.021*	91.681	[3.034]*	67.041	3.913*	74.445
KWD/CHF	4.336*	76.937	287.322*	99.652	14.384*	93.048	180.764*	99.447	41.689*	97.601	[1.589]*	37.086	372.939*	99.731

* Significant at the 5% level, [ ]* Variance ratio is inverted and significant at the 5% level, [ ] Variance ratio is inverted but insignificant at the 5% level

Tables 6.2 to 6.6 also show the results of CC when compared with the unhedged decision. They show that the VR for all of the currency combinations is significant. This result is valid for all of the given risk parameters. However, the relationship under CC between the VD and the value of risk parameter θ is negative. That is, as θ increases, the VD decreases (see Tables 6.7 to 6.11 and Figures 6.4 to 6.6). Linking this relationship to Chapter 3, in which the discussion on CC is presented, this suggests that a higher θ means a greater range for the cash flow to be converted at the current spot rate, S_{t+1} (the neutral zone). The tables show that as θ increases, V_x *(Max)* increases under CC. In addition, as θ increases, $Var.(V_x)$ increases under CC.

Tables 6.2 to 6.6 also show the results of HY when compared with the unhedged decision. They show that the VR for all of the currency combinations is significant. This result is valid for all of the given risk parameters. The relationship under HY (equal weights) between the VD and the value of risk parameter θ is negative. That is, as θ increases, the VD decreases (see Tables 6.7 to 6.11 and Figures 6.7 to 6.9). Linking this relationship to Chapter 3, in which the discussion of HY took place, this relationship suggests that a higher θ means a greater range for the cash flow to be converted at $\bar{S} + S_{t+1}/2$ (the neutral zone). The tables show that as θ increases, V_x *(Max)* increases under HY. In addition, as θ increases, $Var.(V_x)$ increases under HY.

Figures 6.19 to 6.21 show the VD for all of the currency combinations under different operational hedging techniques (RS, CC, and HY equal weights) in a different format. They show that the VD under CC decreases as θ increases, whereas under RS the opposite occurs.

They also show that the behaviour of HY follows the behaviour of a CC, for which the VD decreases as θ increases.

In examining the ranges of V_x *(Max)*, $Var.(V_x)$, VR, and VD for risk parameter θ (Tables 6.7 to 6.11), we notice that under HY, the ranges of $Var.(V_x)$, VR, and VD have a middle value between RS and CC, while the range of V_x *(Max)* has the lowest value compared with RS and CC. This means that the value of payables V_x under HY has the lowest sensitivity to the changes in risk parameter θ compared with RS and CC. Figures 6.22 to 6.24 show the relationship between $Var.(V_x)$ and different risk parameters for RS, CC, and HY (equal weights).

Before discussing the effectiveness of operational hedging versus financial hedging (forward contract), we discuss the effectiveness of financial hedging versus the no-hedge decision (Tables 6.2 to 6.6). The results show that the VR of financial hedging (forward contract) is significant for all of the currency combinations under all of the given risk parameters θ. The VD shows that forward contracts are highly effective in minimising the variance of the unhedged payables by more than 99 per cent. This means that forward hedging is better than RS and HY in minimising the variance of unhedged payables (hypotheses 1, 3, and 4). However, when compared with CC (hypotheses 2 and 4), the results are mixed.

When we compare the effectiveness of financial hedging versus operational hedging (hypotheses 5, 6, and 7), the results (Tables 6.2 to 6.6) show that financial hedging yields much better results than RS for all of the currency combinations under different risk parameters (hypothesis 5). Further, the results show that financial hedging is more effective than HY in minimising risk for all of the currency combinations under different risk parameters (hypothesis 7). However, in relation to financial hedging versus CC, the results are mixed (hypothesis 6).

Figures 6.10 to 6.15 illustrate the domestic-currency value of payables (unhedged) and operational hedging (when θ = 0.002 for both CC and RS) over time. The figures show that operational-hedging volatility is smoother and less volatile than the unhedged position. Figures 6.16 to 6.18 show the behaviour of operational-hedging techniques (RS, CC, and HY equal weights and θ = 0.01) in which the HY line lies between the RS line and the CC line when current spot rates S_{t+1} are sorted into ascending order.

Tables 6.12 to 6.16 agree with the theoretical foundation discussed in Chapter 3 on the behaviour of HY before and after the optimum weight of 0.667, which makes V_x *(Max)*, $Var.(V_x)$, VR, and VD insensitive to a changes in θ. For example the tables show that when the weight of RS is below β<0.667, HY behaviour follows CC behaviour in which as θ increases, V_x *(Max)* and $Var.(V_x)$ increase, whereas VR and VD decrease. However, when the weight of RS exceeds β>0.667, HY behaviour follows RS behaviour in which as θ increases, V_x *(Max)* and $Var.(V_x)$ decrease, whereas VR and VD increase. It is also notable that when the weight of RS is equal to 0.667, as θ increases there are no changes in V_x *(Max)*, $Var.(V_x)$, VR, and VD (see Figures 6.25 to 6.36).

6.5 Conclusion

In this chapter, we examined the effectiveness of financial-hedging techniques—such as forward hedging—versus operational-hedging techniques—such as risk-sharing arrangements, currency collars, and hybrid arrangements—for a domestic firm in the GCC with foreign-currency exposure to the GBP, CHF, and JPY. We found that forward hedging is more effective than either risk-sharing arrangements or hybrid arrangements. However, when compared with currency collars, the results are mixed. We also found that a hybrid-arrangement hedging with a 0.667 weight of risk-sharing arrangements represents the optimum weight at which the maximum value of the domestic-currency value of payables, the variance of domestic-currency value of payables, the variance ratio, and variance reduction become insensitive to changes in risk parameters.

Table 6.3 Results of Hypothesis Testing of SAR

	$H_0: \sigma^2(V_U) = \sigma^2(V_{RS})$		$H_0: \sigma^2(V_U) = \sigma^2(V_{CC})$		$H_0: \sigma^2(V_U) = \sigma^2(V_{HY})$		$H_0: \sigma^2(V_U) = \sigma^2(V_F)$		$H_0: \sigma^2(V_{RS}) = \sigma^2(V_F)$		$H_0: \sigma^2(V_{CC}) = \sigma^2(V_F)$		$H_0: \sigma^2(V_{HY}) = \sigma^2(V_F)$	
	VR	VD (%)	VR	VD (%)	VR	VD (%)	VR	VD (%)	VR	VD (%)	VR	VD (%)	VR	VD (%)
θ= 0.001														
SAR/GBP	4.056*	75.346	13054.808*	99.992	15.728*	93.642	9058.496*	99.988	2233.239*	99.955	[1.441]*	30.611	575.920*	99.826
SAR/JPY	3.875*	74.196	22228.429*	99.995	15.166*	93.406	422.897*	99.763	109.121*	99.083	[52.562]*	98.097	27.884*	96.413
SAR/CHF	3.987*	74.924	37824.741*	99.997	15.699*	93.63	29238.143*	99.996	7331.753*	99.986	[1.293]	22.701	1862.360*	99.946
θ= 0.002														
SAR/GBP	4.120*	75.729	3263.702*	99.969	15.488*	93.543	9058.496*	99.988	2198.538*	99.954	2.775*	63.97	584.855*	99.829
SAR/JPY	3.918*	74.478	5632.421*	99.982	15.001*	93.334	422.897*	99.763	107.927*	99.073	[13.318]*	92.491	28.189*	96.452
SAR/CHF	4.019*	75.123	9492.641*	99.989	15.575*	93.579	29238.143*	99.996	7273.497*	99.986	3.080*	67.533	1877.212*	99.946
θ= 0.004														
SAR/GBP	4.252*	76.484	815.925*	99.877	15.022*	93.343	9058.496*	99.988	2130.177*	99.953	11.102*	90.992	602.986*	99.834
SAR/JPY	4.005*	75.036	1433.636*	99.93	14.680*	93.188	422.897*	99.763	105.568*	99.052	[3.390]*	70.501	28.806*	96.528
SAR/CHF	4.084*	75.517	2378.617*	99.957	15.330*	93.477	29238.143*	99.996	7158.143*	99.986	12.292*	91.864	1907.202*	99.947
θ= 0.006														
SAR/GBP	4.390*	77.223	362.633*	99.724	14.576*	93.139	9058.496*	99.988	2063.204*	99.951	24.979*	95.996	621.464*	99.839
SAR/JPY	4.095*	75.585	646.055*	99.845	14.368*	93.04	422.897*	99.763	103.247*	99.031	[1.527]*	34.541	29.431*	96.602
SAR/CHF	4.150*	75.907	1069.009*	99.906	15.090*	93.373	29238.143*	99.996	7044.294*	99.985	27.350*	96.343	1937.547*	99.948
θ= 0.008														
SAR/GBP	4.534*	77.947	203.981*	99.509	14.147*	92.931	9058.496*	99.988	1997.618*	99.949	44.408*	97.748	640.289*	99.843
SAR/JPY	4.188*	76.125	367.321*	99.727	14.066*	92.89	422.897*	99.763	100.964*	99.009	1.151*	13.141	30.064*	96.673
SAR/CHF	4.217*	76.291	606.292*	99.835	14.854*	93.268	29238.143*	99.996	6931.914*	99.985	48.224*	97.926	1968.251*	99.949
θ= 0.01														
SAR/GBP	4.685*	78.656	131.045*	99.236	13.736*	92.72	9058.496*	99.988	1933.411*	99.948	69.124*	98.553	659.431*	99.848
SAR/JPY	4.283*	76.657	237.642*	99.579	13.772*	92.739	422.897*	99.763	98.716*	98.987	1.779*	43.806	30.705*	96.743
SAR/CHF	4.286*	76.671	392.022*	99.744	14.624*	93.162	29238.143*	99.996	6820.959*	99.985	74.582*	98.659	1999.285*	99.949

* Significant at the 5% level, [ ]* Variance ratio is inverted and significant at the 5% level, [ ] Variance ratio is inverted but insignificant at the 5% level

Table 6.4 Results of Hypothesis Testing of AED

	$H_0: \sigma^2(V_U) = \sigma^2(V_{RS})$		$H_0: \sigma^2(V_U) = \sigma^2(V_{CC})$		$H_0: \sigma^2(V_U) = \sigma^2(V_{HY})$		$H_0: \sigma^2(V_U) = \sigma^2(V_F)$		$H_0: \sigma^2(V_{RS}) = \sigma^2(V_F)$		$H_0: \sigma^2(V_{CC}) = \sigma^2(V_F)$		$H_0: \sigma^2(V_{HY}) = \sigma^2(V_F)$	
	VR	VD (%)	VR	VD (%)	VR	VD (%)	VR	VD (%)	VR	VD (%)	VR	VD (%)	VR	VD (%)
θ= 0.001														
AED/GBP	4.081*	75.499	13229.185*	99.992	15.829*	93.682	5434.649*	99.981	1331.523*	99.924	[2.434]*	58.919	343.327*	99.708
AED/JPY	3.875*	74.196	22778.163*	99.995	15.166*	93.406	534.112*	99.812	137.819*	99.274	[42.646]*	97.655	34.817*	97.127
AED/CHF	4.003*	75.018	36553.021*	99.997	15.754*	93.652	21422.239*	99.995	5351.497*	99.981	[1.706]*	41.394	1359.720*	99.926
θ= 0.002														
AED/GBP	4.145*	75.878	3307.296*	99.969	15.588*	93.585	5434.649*	99.981	1310.938*	99.923	1.643*	39.144	348.627*	99.713
AED/JPY	3.918*	74.478	5734.920*	99.982	15.002*	93.334	534.112*	99.812	136.313*	99.266	[10.737]*	90.686	35.197*	97.158
AED/CHF	4.035*	75.22	9210.445*	99.989	15.628*	93.601	21422.239*	99.995	5308.225*	99.981	2.325*	57.005	1370.756*	99.927
θ= 0.004														
AED/GBP	4.277*	76.624	826.824*	99.879	15.122*	93.387	5434.649*	99.981	1270.384*	99.921	6.572*	84.786	359.382*	99.721
AED/JPY	4.005*	75.035	1453.029*	99.931	14.681*	93.188	534.112*	99.812	133.337*	99.25	[2.720]*	63.241	35.967*	97.219
AED/CHF	4.101*	75.62	2330.694*	99.957	15.378*	93.497	21422.239*	99.995	5222.581*	99.98	9.191*	89.12	1393.025*	99.928
θ= 0.006														
AED/GBP	4.416*	77.355	367.477*	99.727	14.674*	93.185	5434.649*	99.981	1230.651*	99.918	14.789*	93.238	370.342*	99.729
AED/JPY	4.095*	75.584	652.802*	99.846	14.370*	93.041	534.112*	99.812	130.408*	99.233	[1.222]	18.181	36.747*	97.278
AED/CHF	4.169*	76.015	1043.761*	99.904	15.133*	93.392	21422.239*	99.995	5138.097*	99.98	20.524*	95.127	1415.562*	99.929
θ= 0.008														
AED/GBP	4.560*	78.071	207.334*	99.517	14.245*	92.98	5434.649*	99.981	1191.735*	99.916	26.211*	96.184	381.499*	99.737
AED/JPY	4.188*	76.123	369.802*	99.729	14.067*	92.891	534.112*	99.812	127.525*	99.215	1.444*	30.763	37.537*	97.335
AED/CHF	4.238*	76.404	592.648*	99.831	14.893*	93.285	21422.239*	99.995	5054.705*	99.98	36.146*	95.127	1438.363*	99.93
θ= 0.01														
AED/GBP	4.7108*	78.772	132.962*	99.247	13.833*	92.77	5434.649*	99.981	1153.633*	99.913	40.873*	97.553	392.857*	99.745
AED/JPY	4.283*	76.655	237.977*	99.579	13.774*	92.74	534.112*	99.812	124.688*	99.198	2.244*	55.444	38.337*	97.391
AED/CHF	4.308*	76.788	382.279*	99.738	14.658*	93.178	21422.239*	99.995	4972.452*	99.9798	56.038*	98.215	1461.413*	99.931

* Significant at the 5% level, [ ]* Variance ratio is inverted and significant at the 5% level, [ ] Variance ratio is inverted but insignificant at the 5% level

Table 6.5 Results of Hypothesis Testing of QAR

	$H_0: \sigma^2(V_U) = \sigma^2(V_{RS})$		$H_0: \sigma^2(V_U) = \sigma^2(V_{CC})$		$H_0: \sigma^2(V_U) = \sigma^2(V_{HY})$		$H_0: \sigma^2(V_U) = \sigma^2(V_F)$		$H_0: \sigma^2(V_{RS}) = \sigma^2(V_F)$		$H_0: \sigma^2(V_{CC}) = \sigma^2(V_F)$		$H_0: \sigma^2(V_{HY}) = \sigma^2(V_F)$	
	VR	VD (%)	VR	VD (%)	VR	VD (%)	VR	VD (%)	VR	VD (%)	VR	VD (%)	VR	VD (%)
θ= 0.001														
QAR/GBP	4.026*	75.166	10829.245*	99.99	15.567*	93.576	4045.159*	99.975	1004.54*	99.9	[2.677]*	62.645	259.841*	99.615
QAR/JPY	3.899*	74.353	20144.054*	99.995	15.223*	93.431	556.204*	99.82	142.647*	99.298	[36.216]*	97.238	36.535*	97.263
QAR/CHF	3.978*	74.864	16605.753*	99.993	15.521*	93.557	9048.386*	99.988	2274.4	99.956	[1.835]*	45.51	582.958*	99.828
θ= 0.002														
QAR/GBP	4.096*	75.59	2707.885*	99.963	15.307*	93.467	4045.159*	99.9752	987.405*	99.898	1.493*	33.058	264.265*	99.621
QAR/JPY	3.946*	74.664	5079.972*	99.98	15.041*	93.351	556.204*	99.8202	140.919*	99.29	[9.133]*	89.051	36.977*	97.295
QAR/CHF	4.028*	75.176	4151.438*	99.975	15.329*	93.476	9048.386*	99.988	2246.09*	99.955	2.179*	54.119	590.24*	99.83
θ= 0.004														
QAR/GBP	4.241*	76.423	676.995*	99.852	14.803*	93.244	4045.159*	99.975	953.699*	99.895	5.975*	83.264	273.251*	99.634
QAR/JPY	4.045*	75.278	1274.857*	99.921	14.686*	93.19	556.204*	99.82	137.503*	99.272	[2.292]*	56.371	37.872*	97.359
QAR/CHF	4.131*	75.793	1037.859*	99.903	14.955*	93.313	9048.386*	99.988	2190.28*	99.954	8.718*	88.529	605.008*	99.834
θ= 0.006														
QAR/GBP	4.393*	77.238	302.619*	99.669	14.323*	93.018	4045.159*	99.975	920.735*	99.891	13.367*	92.518	282.416*	99.645
QAR/JPY	4.146*	75.882	567.077*	99.823	14.342*	93.027	556.204*	99.82	134.142*	99.254	[1.019]	1.917	38.780*	97.421
QAR/CHF	4.236*	76.398	461.270*	99.783	14.593	93.147	9048.386*	99.988	2135.57*	99.953	19.616*	94.902	620.049*	99.838
θ= 0.008														
QAR/GBP	4.552	78.035	172.293*	99.419	13.865*	92.788	4045.159*	99.975	888.51*	99.887	23.478*	95.74	291.736*	99.657
QAR/JPY	4.251*	76.477	319.088*	99.686	14.009*	92.861	556.204*	99.82	130.836*	99.235	1.7431*	42.631	39.702*	97.481
QAR/CHF	4.3461*	76.991	260.878*	99.616	14.241*	92.978	9048.386*	99.988	2081.91*	99.951	34.684*	97.116	635.347*	99.842
θ= 0.01														
QAR/GBP	4.720*	78.813	110.988*	99.099	13.428*	92.553	4045.159*	99.975	857.009*	99.883	36.446*	97.256	301.233*	99.668
QAR/JPY	4.359*	77.0617	204.252*	99.51	13.686*	92.693	556.204*	99.82	127.584*	99.216	2.723*	63.277	40.638*	97.539
QAR/CHF	4.458*	77.572	167.438*	99.402	13.901*	92.806	9048.386*	99.988	2029.33*	99.95	54.039*	98.149	650.913*	99.846

* Significant at the 5% level, [ ]* Variance ratio is inverted and significant at the 5% level, [ ] Variance ratio is inverted but insignificant at the 5% level

Table 6.6 Results of Hypothesis Testing of BHD

	$H_0\colon \sigma^2(V_U) = \sigma^2(V_{RS})$		$H_0\colon \sigma^2(V_U) = \sigma^2(V_{CC})$		$H_0\colon \sigma^2(V_U) = \sigma^2(V_{HY})$		$H_0\colon \sigma^2(V_U) = \sigma^2(V_F)$		$H_0\colon \sigma^2(V_{RS}) = \sigma^2(V_F)$		$H_0\colon \sigma^2(V_{CC}) = \sigma^2(V_F)$		$H_0\colon \sigma^2(V_{HY}) = \sigma^2(V_F)$	
	VR	VD (%)	VR	VD (%)	VR	VD (%)	VR	VD (%)	VR	VD (%)	VR	VD (%)	VR	VD (%)
θ= 0.001														
BHD/GBP	4.029*	75.18	10242.521*	99.99	15.567*	93.576	6677.986*	99.985	1657.435*	99.939	[1.533]*	34.801	428.956*	99.766
BHD/JPY	3.864*	74.123	19601.128*	99.994	15.101*	93.377	67.869*	98.526	17.562*	94.306	[288.804]*	99.653	775.766*	99.871
BHD/CHF	3.965*	74.781	16932.289*	99.994	15.471*	93.536	10976.756*	99.99	2768.155*	99.963	[1.542]*	35.172	709.469*	99.859
θ= 0.002														
BHD/GBP	4.100*	75.61	2571.555*	99.961	15.303*	93.4654	6677.986*	99.985	1628.724*	99.938	2.596*	61.492	436.376*	99.77
BHD/JPY	3.912*	74.44	4919.107*	99.979	14.920*	93.2978	67.869*	98.526	17.346*	94.235	[72.478]*	98.62	785.148*	99.872
BHD/CHF	4.015*	75.094	4233.072*	99.976	15.281*	93.4561	10976.756*	99.99	2733.780*	99.963	2.593*	61.436	718.306*	99.86
θ= 0.004														
BHD/GBP	4.247*	76.455	643.666*	99.844	14.791*	93.239	6677.986*	99.985	1572.275*	99.936	10.354*	90.342	451.461*	99.778
BHD/JPY	4.011*	75.07	1230.507*	99.918	14.568*	93.135	67.869*	98.526	16.919*	94.089	[18.130]*	94.484	804.131*	99.875
BHD/CHF	4.117*	75.712	1058.268*	99.905	14.909*	93.292	10976.756*	99.99	2666.001*	99.962	10.372*	90.359	736.223*	99.864
θ= 0.006														
BHD/GBP	4.401*	77.281	290.204*	99.655	14.305*	93.009	6677.986*	99.98	1517.134*	99.934	23.011*	95.654	466.826*	99.785
BHD/JPY	4.113*	75.689	546.893*	99.817	14.227*	92.971	67.869*	98.526	16.499*	93.939	[8.057]*	87.589	823.407*	99.878
BHD/CHF	4.222*	76.317	470.341*	99.787	14.549*	93.126	10976.756*	99.99	2599.520*	99.961	23.337*	95.715	754.464*	99.867
θ= 0.008														
BHD/GBP	4.563*	78.088	165.321*	99.395	13.841*	92.775	6677.986*	99.985	1463.248*	99.931	40.393*	97.524	482.470*	99.792
BHD/JPY	4.219*	76.298	308.617*	99.675	13.897*	92.804	67.869*	98.526	16.086*	93.783	[4.547]*	78.008	842.976*	99.881
BHD/CHF	4.331*	76.911	264.567*	99.622	14.199*	92.957	10976.756*	99.99	2534.335*	99.9609	41.489*	97.589	773.030*	99.87
θ= 0.01														
BHD/GBP	4.734*	78.876	106.516*	99.061	13.398*	92.536	6677.986*	99.985	1410.609*	99.929	62.694*	98.404	498.417*	99.799
BHD/JPY	4.328*	76.897	198.249*	99.495	13.577*	92.634	67.869*	98.526	15.679*	93.622	[2.921]*	65.765	862.826*	99.884
BHD/CHF	4.443*	77.493	169.6735*	99.41	13.861*	92.785	10976.756*	99.99	2470.466*	99.959	64.693*	98.454	791.897*	99.873

* Significant at the 5% level, [ ]* Variance ratio is inverted and significant at the 5% level, [ ] Variance ratio is inverted but insignificant at the 5% level

Table 6.7 V_x(Max), Var. (V_x), VR, and VD of KWD

		KWD/GBP			KWD/JPY			KWD/CHF		
	θ	RS	CC	HY (β=0.5)	RS	CC	HY (β=0.5)	RS	CC	HY (β=0.5)
V_x (Max)	0.001	53.372	49.017	51.194	0.317	0.274	0.295	29.081	23.549	26.315
	0.002	53.347	49.066	51.206	0.317	0.274	0.295	29.069	23.572	26.321
	0.004	53.298	49.164	51.231	0.317	0.275	0.296	29.046	23.619	26.333
	0.006	53.249	49.262	51.255	0.316	0.275	0.296	29.022	23.666	26.344
	0.008	53.200	49.36	51.280	0.316	0.276	0.296	28.999	23.713	26.356
	0.01	53.151	49.458	51.304	0.316	0.276	0.296	28.975	23.760	26.368
	range	0.220	0.440	0.110	0.001	0.002	0.0006	0.105	0.211	0.052
Var. (V_x)	0.001	5.611	0.002	1.455	0.000286	7.223E-08	7.35477E-05	3.653	0.0005	0.930
	0.002	5.508	0.009	1.481	0.000282	2.88E-07	7.45201E-05	3.619	0.0021	0.939
	0.004	5.305	0.037	1.535	0.000275	1.142E-06	7.64908E-05	3.551	0.0084	0.957
	0.006	5.108	0.082	1.590	0.000267	2.538E-06	7.84943E-05	3.485	0.0187	0.974
	0.008	4.915	0.146	1.647	0.000260	4.481E-06	8.05315E-05	3.419	0.0327	0.993
	0.01	4.726	0.229	1.704	0.000253	6.957E-06	8.26013E-05	3.355	0.0506	1.011
	range	0.884	0.226	0.249	3.27719E-05	6.885E-06	9.05358E-06	0.298	0.050	0.080
VR	0.001	4.037	9621.17	15.569	3.889	15430	15.153	3.982	26552.287	15.632
	0.002	4.113	2416.24	15.290	3.941	3870	14.955	4.019	6713.739	15.487
	0.004	4.269	607.837	14.751	4.048	976.08	14.570	4.096	1719.957	15.201
	0.006	4.435	273.011	14.240	4.159	439.15	14.198	4.174	777.042	14.922
	0.008	4.609	154.138	13.753	4.273	248.71	13.839	4.254	443.646	14.650
	0.01	4.793	98.814	13.290	4.392	160.2	13.492	4.336	287.322	14.384
	range	0.755	9522.35	2.279	0.502	15270	1.660	0.353	26264.965	1.248
VD	0.001	75.233	99.989	93.577	74.291	99.994	93.400	74.888	99.996	93.603
	0.002	75.687	99.958	93.459	74.631	99.974	93.313	75.123	99.985	93.543
	0.004	76.580	99.835	93.221	75.300	99.898	93.136	75.587	99.941	93.421
	0.006	77.453	99.633	92.977	75.956	99.772	92.957	76.044	99.871	93.298
	0.008	78.306	99.351	92.729	76.600	99.598	92.774	76.494	99.774	93.174
	0.01	79.138	98.988	92.475	77.232	99.376	92.588	76.937	99.651	93.048
	range	3.904	1.001	1.101	2.940	0.617	0.812	2.048	0.344	0.555

Table 6.8 V_x*(Max)*, *Var.* (V_x), VR, and VD of SAR

		SAR/GBP			SAR/JPY			SAR/CHF		
	θ	RS	CC	HY (β=0.5)	RS	CC	HY (β=0.5)	RS	CC	HY (β=0.5)
V_x *(Max)*	0.001	703.921	631.926	667.923	4.215	3.544	3.879	390.035	304.891	347.463
	0.002	703.606	632.557	668.081	4.214	3.547	3.880	389.883	305.195	347.539
	0.004	702.974	633.819	668.397	4.210	3.554	3.882	389.579	305.804	347.691
	0.006	702.343	635.082	668.713	4.207	3.561	3.884	389.274	306.414	347.844
	0.008	701.712	636.345	669.028	4.203	3.568	3.886	388.969	307.023	347.996
	0.01	701.080	637.607	669.344	4.199	3.575	3.887	388.665	307.632	348.148
	range	2.840	5.681	1.420	0.015	0.031	0.007	1.370	2.741	0.685
Var. (V_x)	0.001	1260.757	0.391	325.131	0.065	1.13842E-05	0.0166	879.546	0.092	223.416
	0.002	1241.167	1.566	330.175	0.064	4.4928E-05	0.0168	872.557	0.369	225.197
	0.004	1202.575	6.267	340.411	0.063	0.0001	0.0172	858.719	1.474	228.795
	0.006	1164.765	14.102	350.843	0.061	0.0003	0.0176	845.061	3.281	232.435
	0.008	1127.740	25.070	361.470	0.060	0.0006	0.0179	831.579	5.785	236.119
	0.01	1091.492	39.023	372.276	0.059	0.0010	0.0183	818.269	8.947	239.842
	range	169.265	38.632	47.145	0.006	0.0010	0.0016	61.276	8.854	16.426
VR	0.001	4.056	13054.808	15.728	3.875	22228.429	15.166	3.987	37824.741	15.699
	0.002	4.120	3263.702	15.488	3.918	5632.421	15.001	4.019	9492.641	15.575
	0.004	4.252	815.925	15.022	4.005	1433.636	14.680	4.084	2378.617	15.330
	0.006	4.390	362.633	14.576	4.095	646.055	14.368	4.150	1069.009	15.090
	0.008	4.534	203.981	14.147	4.188	367.321	14.066	4.217	606.292	14.854
	0.01	4.685	131.045	13.736	4.283	237.642	13.772	4.286	392.022	14.624
	range	0.629	12923.763	1.991	0.408	21990.787	1.393	0.298	37432.718	1.0752
VD	0.001	75.346	99.992	93.642	74.196	99.995	93.406	74.924	99.997	93.630
	0.002	75.729	99.969	93.543	74.478	99.982	93.334	75.123	99.989	93.579
	0.004	76.484	99.877	93.343	75.036	99.930	93.188	75.517	99.957	93.477
	0.006	77.223	99.724	93.139	75.585	99.845	93.040	75.907	99.906	93.373
	0.008	77.947	99.509	92.931	76.125	99.727	92.890	76.291	99.835	93.268
	0.01	78.656	99.236	92.720	76.657	99.579	92.739	76.671	99.744	93.162
	range	3.309	0.755	0.921	2.460	0.416	0.667	1.747	0.252	0.468

Table 6.9 V_x*(Max)*, *Var.* (V_x), VR, and VD of AED

	θ	AED/GBP RS	AED/GBP CC	AED/GBP HY (β=0.5)	AED/JPY RS	AED/JPY CC	AED/JPY HY (β=0.5)	AED/CHF RS	AED/CHF CC	AED/CHF HY (β=0.5)
V_x *(Max)*	0.001	690.732	619.907	655.319	4.123	3.472	3.798	383.140	300.896	342.018
	0.002	690.422	620.527	655.474	4.122	3.475	3.799	382.989	301.196	342.093
	0.004	689.803	621.765	655.784	4.1187	3.482	3.800	382.689	301.798	342.243
	0.006	689.183	623.004	656.094	4.115	3.489	3.802	382.388	302.399	342.393
	0.008	688.564	624.242	656.403	4.111	3.496	3.804	382.087	303.000	342.544
	0.01	687.945	625.481	656.713	4.108	3.503	3.805	381.787	303.601	342.694
	range	2.786	5.573	1.393	0.015	0.031	0.007	1.3526	2.705	0.676
Var. (V_x)	0.001	1230.842	0.379	317.367	0.064	1.09469E-05	0.0164	818.528	0.089	207.973
	0.002	1211.813	1.518	322.266	0.063	4.34795E-05	0.0166	811.910	0.355	209.661
	0.004	1174.326	6.075	332.208	0.062	0.0001	0.0169	798.810	1.405	213.067
	0.006	1137.598	13.670	342.339	0.060	0.0003	0.0173	785.888	3.139	216.514
	0.008	1101.624	24.229	352.652	0.059	0.0006	0.0177	773.133	5.528	220.002
	0.01	1066.403	37.782	363.152	0.058	0.0010	0.0181	760.552	8.571	223.527
	range	164.439	37.403	45.785	0.006	0.001	0.001	57.976	8.481	15.554
VR	0.001	4.081	13229.185	15.829	3.875	22778.163	15.166	4.003	36553.021	15.754
	0.002	4.145	3307.296	15.588	3.918	5734.920	15.002	4.035	9210.445	15.628
	0.004	4.277	826.824	15.122	4.005	1453.029	14.681	4.101	2330.694	15.378
	0.006	4.416	367.477	14.674	4.095	652.802	14.370	4.169	1043.761	15.133
	0.008	4.560	207.334	14.245	4.188	369.802	14.067	4.238	592.648	14.893
	0.01	4.710	132.962	13.833	4.283	237.977	13.774	4.308	382.279	14.6585
	range	0.629	13096.222	1.995	0.408	22540.186	1.392	0.305	36170.741	1.096
VD	0.001	75.499	99.992	93.682	74.196	99.995	93.406	75.018	99.997	93.652
	0.002	75.878	99.969	93.585	74.478	99.982	93.334	75.220	99.989	93.601
	0.004	76.624	99.879	93.387	75.035	99.931	93.188	75.620	99.957	93.497
	0.006	77.355	99.727	93.185	75.584	99.846	93.041	76.015	99.904	93.392
	0.008	78.071	99.517	92.980	76.123	99.729	92.891	76.404	99.831	93.285
	0.01	78.772	99.247	92.771	76.655	99.579	92.740	76.788	99.738	93.178
	range	3.273	0.744	0.911	2.458	0.415	0.666	1.769	0.258	0.474

Table 6.10 V_x(Max), Var. (V_x), VR, and VD of QAR

		QAR/GBP			QAR/JPY			QAR/CHF		
	θ	RS	CC	HY (β=0.5)	RS	CC	HY (β=0.5)	RS	CC	HY (β=0.5)
V_x (Max)	0.001	697.598	641.133	669.366	4.179	3.627	3.903	395.541	329.766	362.653
	0.002	697.278	641.774	669.526	4.178	3.631	3.904	395.376	330.095	362.736
	0.004	696.638	643.055	669.846	4.174	3.638	3.906	395.047	330.754	362.900
	0.006	695.997	644.336	670.166	4.170	3.645	3.908	394.717	331.413	363.065
	0.008	695.357	645.617	670.487	4.167	3.653	3.910	394.388	332.072	363.230
	0.01	694.716	646.898	670.807	4.163	3.660	3.912	394.058	332.731	363.394
	range	2.882	5.764	1.441	0.016	0.032	0.0081	1.482	2.964	0.741
Var. (V_x)	0.001	1102.172	0.409	285.096	0.067	1.31142E-05	0.0173	452.289	0.108	115.927
	0.002	1083.373	1.639	289.949	0.066	5.20029E-05	0.0175	446.659	0.433	117.376
	0.004	1046.391	6.555	299.809	0.065	0.0002	0.0179	435.562	1.733	120.312
	0.006	1010.223	14.666	309.865	0.063	0.0004	0.0184	424.682	3.900	123.303
	0.008	974.867	25.760	320.091	0.062	0.0008	0.0188	414.011	6.897	126.346
	0.01	940.304	39.988	330.510	0.060	0.0012	0.0193	403.554	10.746	129.441
	range	161.867	39.579	45.415	0.0071	0.0012	0.0019	48.735	10.638	13.513
VR	0.001	4.026	10829.245	15.567	3.899	20144.054	15.223	3.978	16605.753	15.521
	0.002	4.096	2707.885	15.307	3.946	5079.972	15.041	4.028	4151.438	15.329
	0.004	4.241	676.995	14.803	4.045	1274.857	14.686	4.131	1037.859	14.955
	0.006	4.393	302.619	14.323	4.146	567.077	14.342	4.236	461.270	14.593
	0.008	4.552	172.293	13.865	4.251	319.088	14.009	4.346	260.878	14.241
	0.01	4.720	110.988	13.428	4.359	204.252	13.686	4.4588	167.438	13.901
	range	0.693	10718.256	2.139	0.460	19939.802	1.536	0.480	16438.314	1.620
VD	0.001	75.166	99.990	93.576	74.353	99.995	93.431	74.864	99.993	93.557
	0.002	75.590	99.963	93.467	74.664	99.980	93.351	75.176	99.975	93.476
	0.004	76.423	99.852	93.244	75.278	99.921	93.190	75.793	99.903	93.313
	0.006	77.238	99.669	93.018	75.882	99.823	93.027	76.398	99.783	93.147
	0.008	78.035	99.419	92.788	76.477	99.686	92.861	76.991	99.616	92.978
	0.01	78.813	99.099	92.553	77.061	99.510	92.693	77.572	99.402	92.806
	range	3.647	0.891	1.023	2.708	0.484	0.737	2.708	0.591	0.751

Table 6.11 V_x*(Max)*, *Var.* (V_x), VR, and VD of BHD

		BHD/GBP			BHD/JPY			BHD/CHF		
	θ	RS	CC	HY (β=0.5)	RS	CC	HY (β=0.5)	RS	CC	HY (β=0.5)
V_x *(Max)*	0.001	72.248	66.429	69.339	0.4339	0.3756	0.4048	40.860	33.958	37.409
	0.002	72.214	66.496	69.355	0.4337	0.3760	0.4049	40.843	33.992	37.417
	0.004	72.148	66.629	69.388	0.4333	0.3767	0.4050	40.809	34.060	37.434
	0.006	72.082	66.761	69.422	0.4330	0.3775	0.4052	40.775	34.127	37.451
	0.008	72.015	66.894	69.455	0.4326	0.3782	0.4054	40.741	34.195	37.468
	0.01	71.949	67.027	69.488	0.4322	0.3790	0.4056	40.707	34.263	37.485
	range	0.298	0.597	0.149	0.0016	0.0033	0.0008	0.152	0.305	0.076
Var. (V_x)	0.001	11.197	0.0044	2.898	0.00071	1.39093E-07	0.000184	4.853	0.001	1.243
	0.002	11.004	0.017	2.948	0.00071	5.56372E-07	0.000186	4.792	0.004	1.259
	0.004	10.622	0.070	3.050	0.00069	2.22549E-06	0.000191	4.674	0.018	1.290
	0.006	10.250	0.155	3.153	0.00067	5.00735E-06	0.000195	4.557	0.040	1.322
	0.008	9.886	0.272	3.259	0.00066	8.90195E-06	0.000200	4.443	0.072	1.355
	0.01	9.530	0.423	3.367	0.00064	1.3879E-05	0.000205	4.331	0.113	1.388
	range	1.667	0.419	0.469	7.58834E-05	1.37399E-05	2.06883E-05	0.521	0.112	0.144
VR	0.001	4.029	10242.521	15.567	3.867	20014.514	15.101	3.965	16932.289	15.471
	0.002	4.100	2571.555	15.303	3.915	5003.628	14.920	4.015	4233.072	15.281
	0.004	4.247	643.666	14.791	4.012	1250.907	14.568	4.117	1058.268	14.909
	0.006	4.401	290.204	14.305	4.112	555.958	14.227	4.222	470.341	14.549
	0.008	4.563	165.321	13.841	4.216	312.726	13.897	4.331	264.5670	14.199
	0.01	4.734	106.516	13.398	4.323	200.582	13.577	4.4431	169.673	13.861
	range	0.7050	10136.004	2.169	0.4558	19813.932	1.523	0.477	16762.615	1.610
VD	0.001	75.180	99.990	93.576	74.145	99.995	93.377	74.781	99.994	93.536
	0.002	75.610	99.961	93.465	74.457	99.980	93.297	75.094	99.976	93.456
	0.004	76.455	99.844	93.239	75.076	99.920	93.135	75.712	99.905	93.292
	0.006	77.281	99.655	93.009	75.684	99.820	92.971	76.317	99.787	93.126
	0.008	78.088	99.395	92.775	76.282	99.680	92.804	76.911	99.622	92.957
	0.01	78.876	99.061	92.536	76.870	99.501	92.634	77.493	99.410	92.785
	range	3.696	0.929	1.0401	2.725	0.493	0.743	2.711	0.583	0.750

Table 6.12 Sensitivity of KWD to Changes in θ under HY (different weights)

		KWD/GBP				KWD/JPY				KWD/CHF			
	θ	V_x (Max)	Var. (V_x)	VR	VD (%)	V_x (Max)	Var. (V_x)	VR	VD (%)	V_x (Max)	Var. (V_x)	VR	VD (%)
β=0.10	0.001	49.452	0.076	295.578	99.661	0.278	3.6E-06	308.932	99.676	24.102	0.043	337.134	99.703
	0.002	49.494	0.099	227.658	99.560	0.278	4.4E-06	252.404	99.603	24.122	0.050	289.804	99.654
	0.004	49.577	0.155	145.928	99.314	0.279	6.3E-06	175.894	99.431	24.162	0.066	218.805	99.543
	0.006	49.660	0.223	101.216	99.012	0.279	8.6E-06	128.876	99.224	24.202	0.085	169.876	99.411
	0.008	49.744	0.305	74.127	98.651	0.280	1.1E-05	98.154	98.981	24.242	0.107	135.294	99.260
	0.01	49.827	0.400	56.548	98.231	0.280	1.4E-05	77.151	98.703	24.282	0.132	110.098	99.091
	range	0.374	0.324	239.029	1.430	0.0021	1.1E-05	231.78	0.9724	0.179	0.088	227.036	0.61167
β=0.50	0.001	51.194	1.455	15.569	93.577	0.295	7.4E-05	15.153	93.400	26.315	0.930	15.633	93.603
	0.002	51.206	1.481	15.290	93.459	0.295	7.5E-05	14.955	93.313	26.321	0.939	15.487	93.543
	0.004	51.231	1.535	14.751	93.221	0.296	7.6E-05	14.570	93.136	26.333	0.957	15.201	93.421
	0.006	51.255	1.590	14.240	92.977	0.296	7.8E-05	14.198	92.957	26.344	0.974	14.922	93.298
	0.008	51.280	1.647	13.754	92.729	0.296	8.1E-05	13.839	92.774	26.356	0.993	14.650	93.174
	0.01	51.304	1.704	13.290	92.475	0.296	8.3E-05	13.492	92.588	26.368	1.011	14.384	93.048
	range	0.110	0.249	2.279	1.101	0.0006	9.1E-06	1.660	0.812	0.0529	0.080	1.248	0.555
β=0.666	0.001	51.868	2.535	8.937	88.810	0.302	0.0001	8.654	88.445	27.210	1.635	8.894	88.756
	0.002	51.868	2.535	8.937	88.810	0.302	0.0001	8.654	88.445	27.210	1.635	8.894	88.756
	0.004	51.868	2.535	8.937	88.810	0.302	0.0001	8.654	88.445	27.210	1.635	8.894	88.756
	0.006	51.868	2.535	8.937	88.810	0.302	0.0001	8.654	88.445	27.210	1.635	8.894	88.756
	0.008	51.868	2.535	8.937	88.810	0.302	0.0001	8.654	88.445	27.210	1.635	8.894	88.756
	0.01	51.868	2.535	8.937	88.810	0.302	0.0001	8.654	88.445	27.210	1.635	8.894	88.756
	range	0	0	0	0	0	0	0	0	0	0	0	0
β=0.90	0.001	52.936	4.563	4.964	79.856	0.313	0.00023	4.788	79.114	28.528	2.965	4.906	79.617
	0.002	52.919	4.498	5.036	80.144	0.313	0.00023	4.837	79.329	28.520	2.943	4.942	79.765
	0.004	52.885	4.370	5.184	80.710	0.312	0.00023	4.939	79.753	28.503	2.901	5.014	80.059
	0.006	52.850	4.244	5.338	81.267	0.312	0.00022	5.043	80.171	28.487	2.858	5.088	80.349
	0.008	52.816	4.120	5.498	81.814	0.312	0.00022	5.150	80.583	28.470	2.817	5.164	80.636
	0.01	52.782	3.998	5.666	82.351	0.312	0.00021	5.260	80.989	28.454	2.775	5.241	80.92
	range	0.154	0.565	0.701	2.495	0.0008	2.1E-05	0.472	1.874	0.0741	0.189	0.334	1.302

Table 6.13 Sensitivity of SAR to Changes in θ under HY (different weights)

		SAR/GBP				SAR/JPY				SAR/CHF			
	θ	V_x *(Max)*	*Var.* (V_x)	VR	VD (%)	V_x *(Max)*	*Var.* (V_x)	VR	VD (%)	V_x *(Max)*	*Var.* (V_x)	VR	VD (%)
β=0.10	0.001	639.126	16.468	310.522	99.678	3.611	0.0007	319.833	99.687	313.406	10.132	346.153	99.711
	0.002	639.662	20.698	247.072	99.595	3.614	0.0009	269.698	99.629	313.664	11.532	304.138	99.671
	0.004	640.735	30.854	165.741	99.396	3.620	0.0012	197.863	99.494	314.182	14.730	238.112	99.58
	0.006	641.809	43.275	118.17	99.153	3.626	0.0016	150.657	99.336	314.7	18.434	190.271	99.474
	0.008	642.882	57.961	88.230	98.866	3.632	0.0021	118.288	99.154	315.218	22.641	154.913	99.354
	0.01	643.955	74.797	68.37	98.537	3.638	0.0026	95.293	98.950	315.736	27.323	128.37	99.221
	range	4.829	58.328	242.152	1.140	0.027	0.0018	224.539	0.736	2.330	17.190	217.783	0.490
β=0.50	0.001	667.924	325.131	15.7287	93.6422	3.879	0.0166	15.166	93.406	347.464	223.416	15.6995	93.6304
	0.002	668.082	330.176	15.4884	93.5436	3.880	0.0168	15.002	93.334	347.54	225.198	15.5753	93.5796
	0.004	668.397	340.412	15.0227	93.3434	3.882	0.0172	14.680	93.188	347.692	228.796	15.3304	93.477
	0.006	668.713	350.843	14.576	93.1394	3.884	0.0176	14.368	93.040	347.844	232.436	15.0903	93.3732
	0.008	669.029	361.471	14.1475	92.9316	3.886	0.0179	14.066	92.890	347.997	236.119	14.8549	93.2682
	0.01	669.344	372.277	13.7368	92.7203	3.887	0.0183	13.772	92.739	348.149	239.842	14.6243	93.1621
	range	1.42041	47.145	1.991	0.921	0.007	0.0016	1.393	0.667	0.685	16.426	1.075	0.468
β=0.666	0.001	679.243	567.993	9.003	88.893	3.987	0.029	8.642	88.428	361.293	393.249	8.919	88.788
	0.002	679.243	567.993	9.003	88.893	3.987	0.029	8.642	88.428	361.293	393.249	8.919	88.788
	0.004	679.243	567.993	9.003	88.893	3.987	0.029	8.642	88.428	361.293	393.249	8.919	88.788
	0.006	679.243	567.993	9.003	88.893	3.987	0.029	8.642	88.428	361.293	393.249	8.919	88.788
	0.008	679.243	567.993	9.003	88.893	3.987	0.029	8.642	88.428	361.293	393.249	8.919	88.788
	0.01	679.243	567.993	9.003	88.893	3.987	0.029	8.642	88.428	361.293	393.249	8.919	88.788
	range	0	0.00	0.00	0	0	0.00	0	0	0	0.00	0	0
β=0.90	0.001	696.722	1024.76	4.990	79.961	4.148	0.053	4.772	79.048	381.521	713.696	4.914	79.652
	0.002	696.501	1012.38	5.051	80.203	4.147	0.052	4.813	79.226	381.415	709.283	4.945	79.778
	0.004	696.059	987.901	5.176	80.682	4.144	0.051	4.897	79.579	381.202	700.526	5.006	80.027
	0.006	695.617	963.807	5.305	81.153	4.142	0.050	4.982	79.928	380.988	691.859	5.069	80.275
	0.008	695.176	940.097	5.439	81.616	4.14	0.049	5.069	80.272	380.775	683.278	5.133	80.519
	0.01	694.734	916.772	5.578	82.072	4.137	0.049	5.158	80.612	380.562	674.781	5.198	80.761
	range	1.988	107.989	0.587	2.111	0.011	0.00396	0.385	1.564	0.959	38.914	0.283	1.109

Table 6.14 Sensitivity of AED to Changes in θ under HY (different weights)

		AED/GBP				AED/JPY				AED/CHF			
	θ	V_x *(Max)*	*Var.* (V_x)	VR	VD (%)	V_x *(Max)*	*Var.* (V_x)	VR	VD (%)	V_x *(Max)*	*Var.* (V_x)	VR	VD (%)
β=0.10	0.001	626.99	16.058	312.843	99.680	3.537	0.0007	319.99	99.687	309.121	9.452	346.63	99.711
	0.002	627.517	20.164	249.135	99.598	3.540	0.0009	269.973	99.629	309.376	10.781	303.91	99.671
	0.004	628.569	30.023	167.326	99.402	3.546	0.0012	198.239	99.495	309.887	13.811	237.233	99.578
	0.006	629.622	42.077	119.392	99.162	3.552	0.0016	151.009	99.337	310.398	17.334	189.022	99.471
	0.008	630.675	56.270	89.277	98.879	3.558	0.0021	118.533	99.156	310.909	21.330	153.608	99.349
	0.01	656.713	361.486	13.897	92.804	3.564	0.0026	95.370	98.951	311.42	25.797	127.014	99.212
	range	29.7231	345.428	298.946	6.875	0.026	0.001	224.619	0.736	2.299	16.344	219.615	0.498
β=0.50	0.001	655.32	317.367	15.829	93.682	3.798	0.0164	15.166	93.406	342.018	207.974	15.754	93.652
	0.002	655.475	322.267	15.588	93.585	3.799	0.0166	15.002	93.334	342.093	209.662	15.628	93.601
	0.004	655.784	332.208	15.122	93.387	3.800	0.0169	14.681	93.188	342.244	213.068	15.378	93.497
	0.006	656.094	342.34	14.674	93.185	3.802	0.0173	14.370	93.041	342.394	216.515	15.133	93.392
	0.008	656.404	352.653	14.245	92.980	3.804	0.0177	14.067	92.891	342.544	220.002	14.893	93.285
	0.01	656.713	363.152	13.833	92.771	3.806	0.018	13.774	92.74	342.695	223.528	14.658	93.178
	range	1.393	45.785	1.995	0.911	0.007	0.001	1.392	0.666	0.676	15.554	1.096	0.474
β=0.666	0.001	666.457	554.472	9.060	88.962	3.902	0.028	8.642	88.428	355.37	366.018	8.952	88.829
	0.002	666.457	554.472	9.060	88.962	3.902	0.028	8.642	88.428	355.37	366.018	8.952	88.829
	0.004	666.457	554.472	9.060	88.962	3.902	0.028	8.642	88.428	355.37	366.018	8.952	88.829
	0.006	666.457	554.472	9.060	88.962	3.902	0.028	8.642	88.428	355.37	366.018	8.952	88.829
	0.008	666.457	554.472	9.060	88.962	3.902	0.028	8.642	88.428	355.37	366.018	8.952	88.829
	0.01	666.457	554.472	9.060	88.962	3.902	0.028	8.642	88.428	355.37	366.018	8.952	88.829
	range	0	0.00	0.00	0	0	0.00	0	0	0	0.00	0	0
β=0.90	0.001	683.65	1000.43	5.021	80.085	4.058	0.052	4.772	79.048	374.916	664.204	4.933	79.728
	0.002	683.433	988.401	5.082	80.325	4.057	0.051	4.813	79.226	374.811	660.025	4.964	79.856
	0.004	682.999	964.624	5.207	80.798	4.055	0.050	4.896	79.579	374.6	651.736	5.027	80.109
	0.006	682.566	941.219	5.337	81.264	4.052	0.050	4.981	79.927	374.39	643.534	5.091	80.359
	0.008	682.132	918.187	5.471	81.723	4.050	0.049	5.068	80.271	374.179	635.415	5.156	80.607
	0.01	681.699	895.523	5.609	82.174	4.047	0.048	5.157	80.611	373.969	627.382	5.222	80.852
	range	1.950	104.906	0.588	2.088	0.010	0.0039	0.384	1.563	0.946	36.821	0.289	1.123

Table 6.15 Sensitivity of QAR to Changes in θ under HY (different weights)

		QAR/GBP				QAR/JPY				QAR/CHF			
	θ	V_x (Max)	Var. (V_x)	VR	VD (%)	V_x (Max)	Var. (V_x)	VR	VD (%)	V_x (Max)	Var. (V_x)	VR	VD (%)
β=0.10	0.001	646.78	14.756	300.781	99.667	3.683	0.0008	315.847	99.683	336.344	5.628	319.667	99.687
	0.002	647.325	18.892	234.93	99.574	3.686	0.0010	262.684	99.619	336.624	6.834	263.272	99.620
	0.004	648.414	28.940	153.36	99.347	3.692	0.0014	188.671	99.47	337.184	9.715	185.199	99.46
	0.006	649.502	41.293	107.48	99.069	3.698	0.0018	141.314	99.292	337.744	13.223	136.075	99.265
	0.008	650.591	55.790	79.552	98.743	3.704	0.0024	109.463	99.086	338.304	17.329	103.832	99.036
	0.01	651.68	72.551	61.174	98.365	3.710	0.0030	87.127	98.852	338.864	22.052	81.5968	98.774
	range	9.799	1003.8	296.423	22.616	0.055	0.002	298.087	0.888	5.040	17.472	311.302	0.9710
β=0.50	0.001	669.366	285.09	15.567	93.576	3.903	0.0173	15.223	93.431	362.654	115.928	15.521	93.557
	0.002	669.526	289.95	15.307	93.467	3.904	0.0175	15.041	93.351	362.736	117.376	15.33	93.476
	0.004	669.847	299.81	14.803	93.245	3.906	0.0179	14.686	93.190	362.901	120.313	14.955	93.313
	0.006	670.167	309.866	14.323	93.018	3.908	0.0184	14.342	93.027	363.065	123.304	14.593	93.147
	0.008	670.487	320.091	13.865	92.788	3.910	0.0188	14.009	92.861	363.23	126.346	14.241	92.978
	0.01	670.807	330.511	13.428	92.553	3.912	0.0193	13.686	92.693	363.395	129.441	13.901	92.806
	range	1.441	45.414	2.139	1.023	0.008	0.0019	1.536	0.737	0.7412	13.513	1.6204	0.751
β=0.666	0.001	678.098	497.305	8.924	88.795	3.991	0.030	8.684	88.485	373.243	203.137	8.857	88.710
	0.002	678.098	497.305	8.924	88.795	3.991	0.030	8.684	88.485	373.243	203.137	8.857	88.710
	0.004	678.098	497.305	8.924	88.795	3.991	0.030	8.684	88.485	373.243	203.137	8.857	88.710
	0.006	678.098	497.305	8.924	88.795	3.991	0.030	8.684	88.485	373.243	203.137	8.857	88.710
	0.008	678.098	497.305	8.924	88.795	3.991	0.030	8.684	88.485	373.243	203.137	8.857	88.710
	0.01	678.098	497.305	8.924	88.795	3.991	0.030	8.684	88.485	373.243	203.137	8.857	88.710
	range	0	0.00	0.00	0	0	0	0	0	0	0.00	0.00	0
β=0.90	0.001	691.952	896.166	4.952	79.808	4.124	0.055	4.800	79.170	388.964	367.374	4.897	79.583
	0.002	691.728	884.28	5.019	80.076	4.123	0.054	4.846	79.366	388.848	363.816	4.945	79.781
	0.004	691.28	860.809	5.155	80.605	4.120	0.053	4.939	79.755	388.618	356.779	5.043	80.172
	0.006	690.831	837.739	5.297	81.124	4.118	0.052	5.035	80.139	388.387	349.849	5.143	80.557
	0.008	690.383	815.076	5.445	81.635	4.115	0.051	5.133	80.518	388.157	343.021	5.245	80.936
	0.01	689.935	792.804	5.598	82.137	4.113	0.050	5.233	80.893	387.926	336.299	5.350	81.310
	range	2.017	103.362	0.645	2.328	0.011	0.004	0.432	1.723	1.037	31.075	0.452	1.727

Table 6.16 Sensitivity of BHD to Changes in θ under HY (different weights)

		BHD/GBP				BHD/JPY				BHD/CHF			
	θ	V_x (Max)	Var. (V_x)	VR	VD (%)	V_x (Max)	Var. (V_x)	VR	VD (%)	V_x (Max)	Var. (V_x)	VR	VD (%)
β=0.10	0.001	67.011	0.150	299.477	99.666	0.3814	8.9E-06	313.349	99.680	34.648	0.060	318.875	99.686
	0.002	67.068	0.193	232.947	99.570	0.3818	1.1E-05	260.563	99.616	34.677	0.073	262.885	99.619
	0.004	67.181	0.298	151.038	99.337	0.3824	1.5E-05	187.005	99.465	34.735	0.103	185.329	99.460
	0.006	67.293	0.427	105.573	99.052	0.3830	2E-05	139.942	99.285	34.792	0.141	136.444	99.267
	0.008	67.406	0.579	77.911	98.716	0.3837	2.6E-05	108.307	99.076	34.850	0.184	104.128	99.039
	0.01	67.519	0.754	59.773	98.327	0.3843	3.2E-05	86.200	98.839	34.908	0.234	81.900	98.779
	range	0.507	0.604	239.704	1.339	0.002	2.3E-05	227.148	0.840	0.259	0.174	236.974	0.907
β=0.50	0.001	69.339	2.898	15.568	93.576	0.4048	0.00018	15.101	93.378	37.409	1.243	15.471	93.536
	0.002	69.355	2.948	15.303	93.465	0.4049	0.00019	14.920	93.297	37.417	1.259	15.281	93.456
	0.004	69.388	3.050	14.791	93.239	0.4050	0.00019	14.568	93.135	37.434	1.290	14.909	93.292
	0.006	69.422	3.153	14.305	93.009	0.4052	0.0002	14.227	92.971	37.451	1.322	14.549	93.126
	0.008	69.455	3.259	13.841	92.775	0.4054	0.0002	13.897	92.804	37.468	1.355	14.199	92.957
	0.01	69.488	3.367	13.398	92.536	0.4056	0.00021	13.577	92.634	37.485	1.388	13.861	92.785
	range	0.149	0.469	2.169	1.040	0.0008	2.1E-05	1.523	0.743	0.076	0.144	1.610	0.750
β=0.666	0.001	70.238	5.053	8.927	88.798	0.414	0.0003	8.614	88.392	38.521	2.179	8.829	88.674
	0.002	70.238	5.053	8.927	88.798	0.414	0.0003	8.614	88.392	38.521	2.179	8.829	88.674
	0.004	70.238	5.053	8.927	88.798	0.414	0.0003	8.614	88.392	38.521	2.179	8.829	88.674
	0.006	70.238	5.053	8.927	88.798	0.414	0.0003	8.614	88.392	38.521	2.179	8.829	88.674
	0.008	70.238	5.053	8.927	88.798	0.414	0.0003	8.614	88.392	38.521	2.179	8.829	88.674
	0.01	70.238	5.053	8.927	88.798	0.414	0.0003	8.614	88.392	38.521	2.179	8.829	88.674
	range	0	0.00	0.00	0	0	0.00	0	0	0	0	0	0
β=0.90	0.001	71.666	9.105	4.955	79.818	0.428	0.00058	4.762	79.000	40.17	3.941	4.881	79.516
	0.002	71.643	8.982	5.022	80.090	0.428	0.00058	4.807	79.198	40.158	3.903	4.929	79.714
	0.004	71.596	8.740	5.161	80.626	0.427	0.00057	4.899	79.590	40.134	3.828	5.026	80.105
	0.006	71.550	8.503	5.306	81.153	0.427	0.00056	4.994	79.976	40.110	3.754	5.125	80.491
	0.008	71.503	8.269	5.455	81.671	0.427	0.00055	5.091	80.358	40.086	3.681	5.227	80.871
	0.01	71.457	8.040	5.611	82.179	0.426	0.00054	5.190	80.735	40.063	3.609	5.332	81.245
	range	0.209	1.065	0.656	2.361	0.001	4.8E-05	0.428	1.734	0.106	0.332	0.450	1.728

Figure 6.1 VR and VD under RS for GCC Currencies against GBP

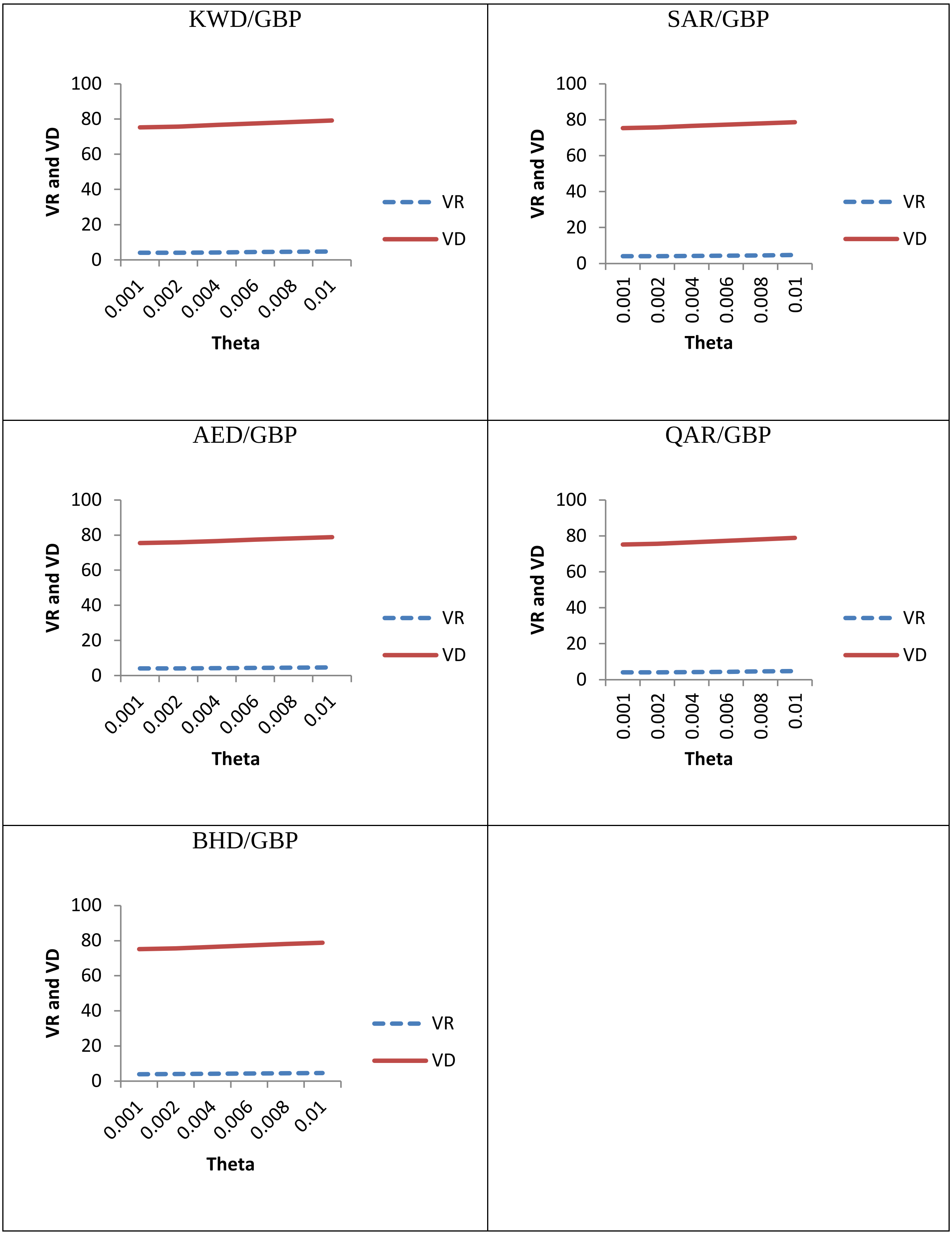


Figure 6.2 VR and VD under RS for GCC Currencies against JPY

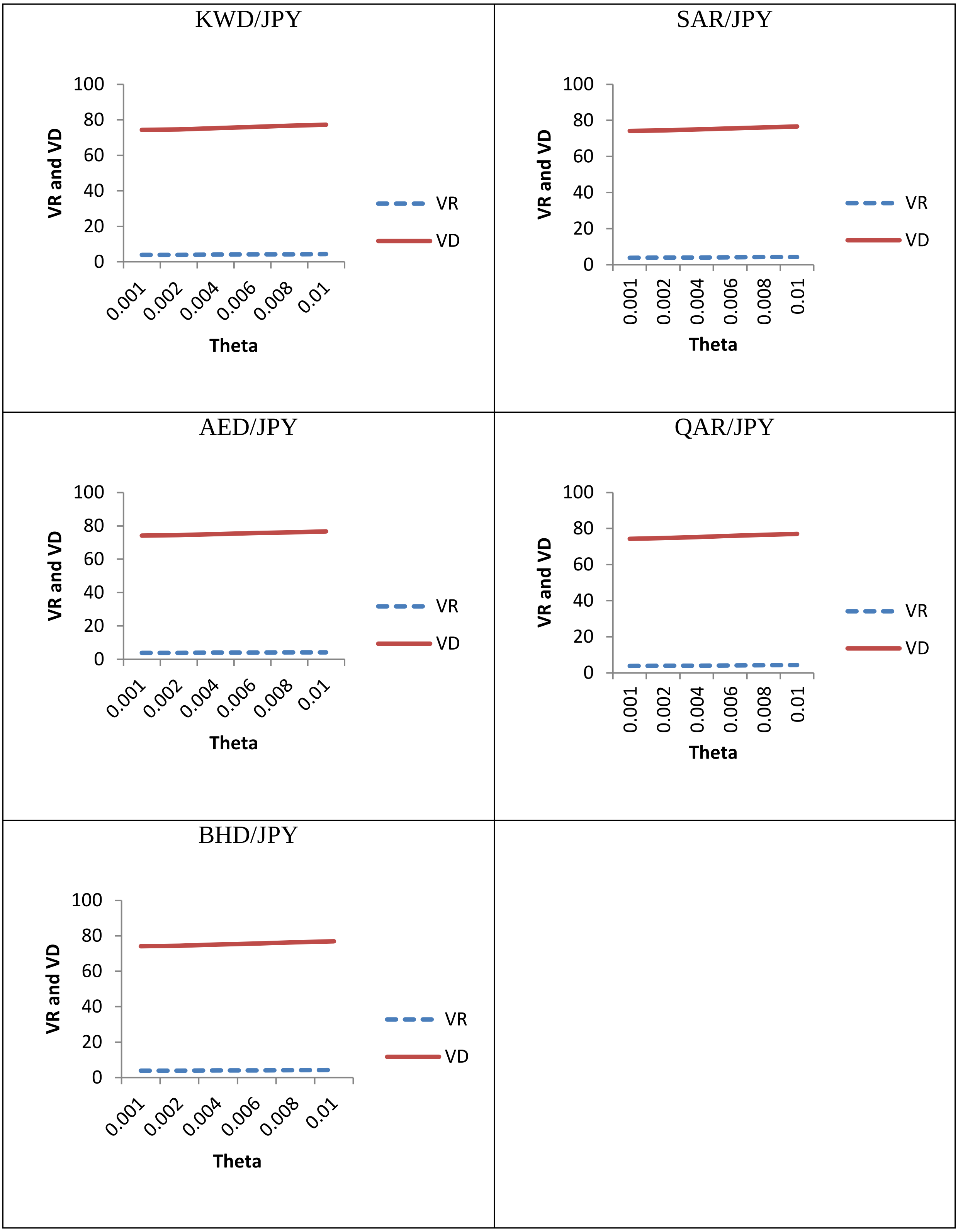


Figure 6.3 VR and VD under RS for GCC Currencies against CHF

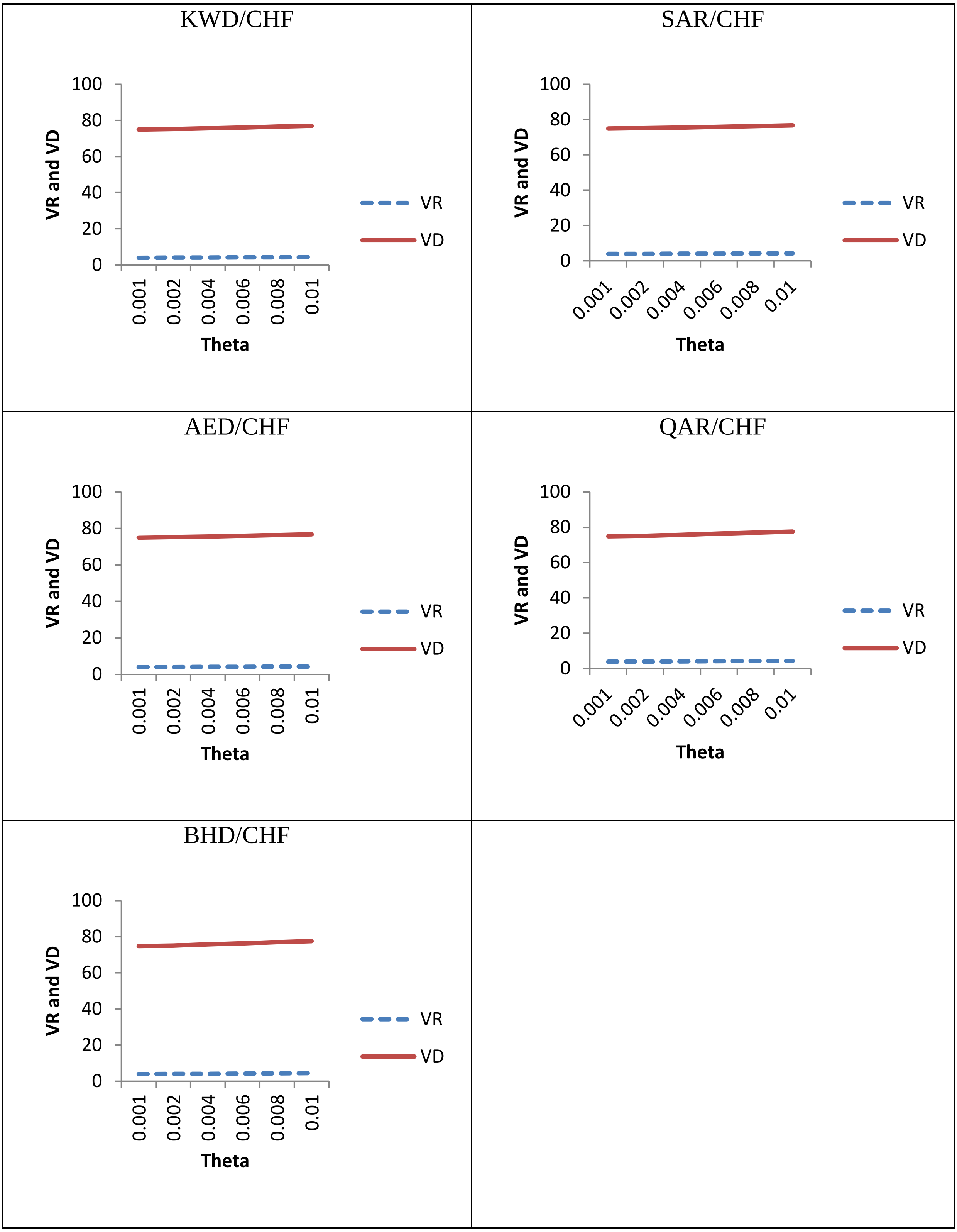


Figure 6.4 VR and VD under CC for GCC Currencies against GBP

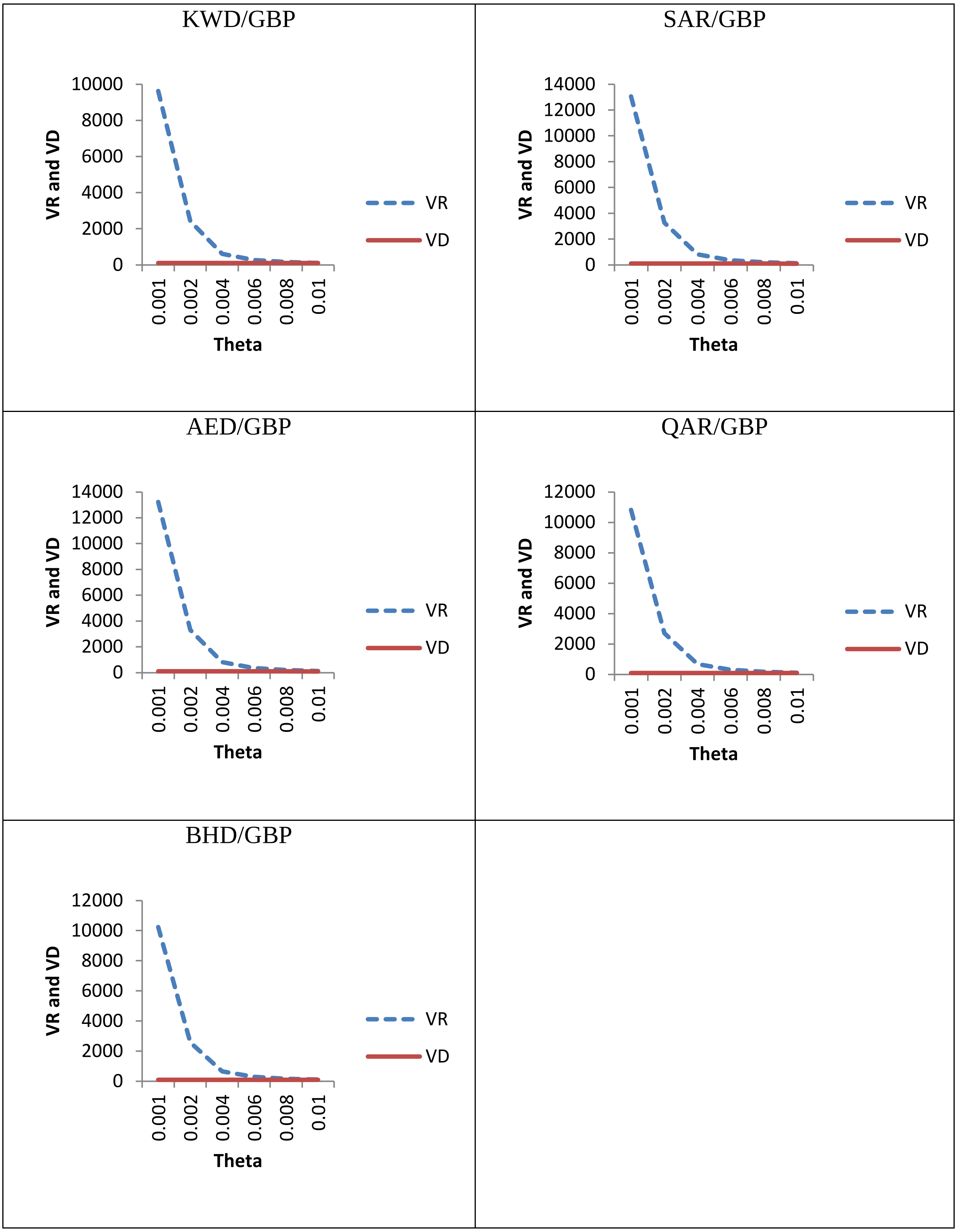


Figure 6.5 VR and VD under CC for GCC Currencies against JPY

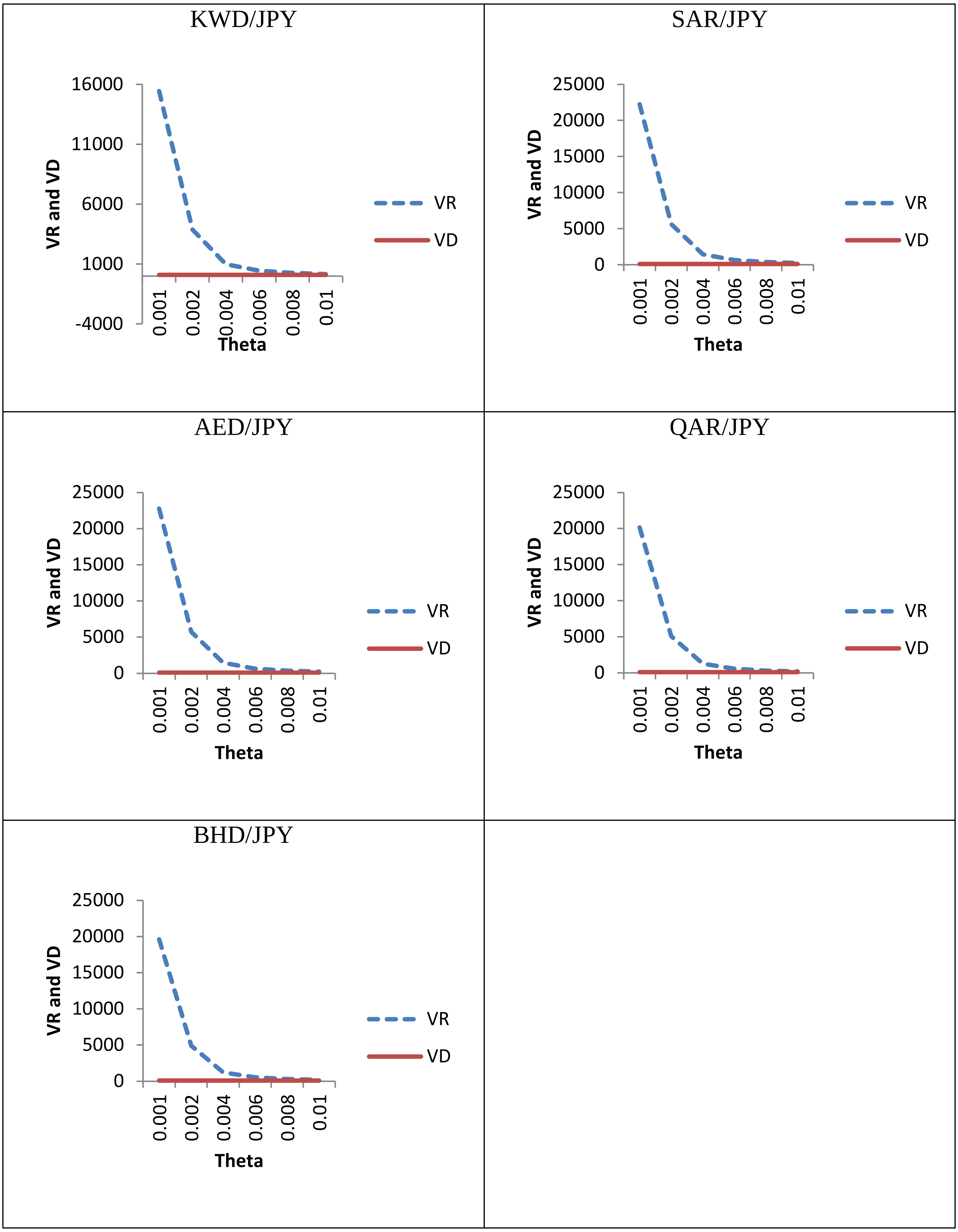


Figure 6.6 VR and VD under CC for GCC Currencies against CHF

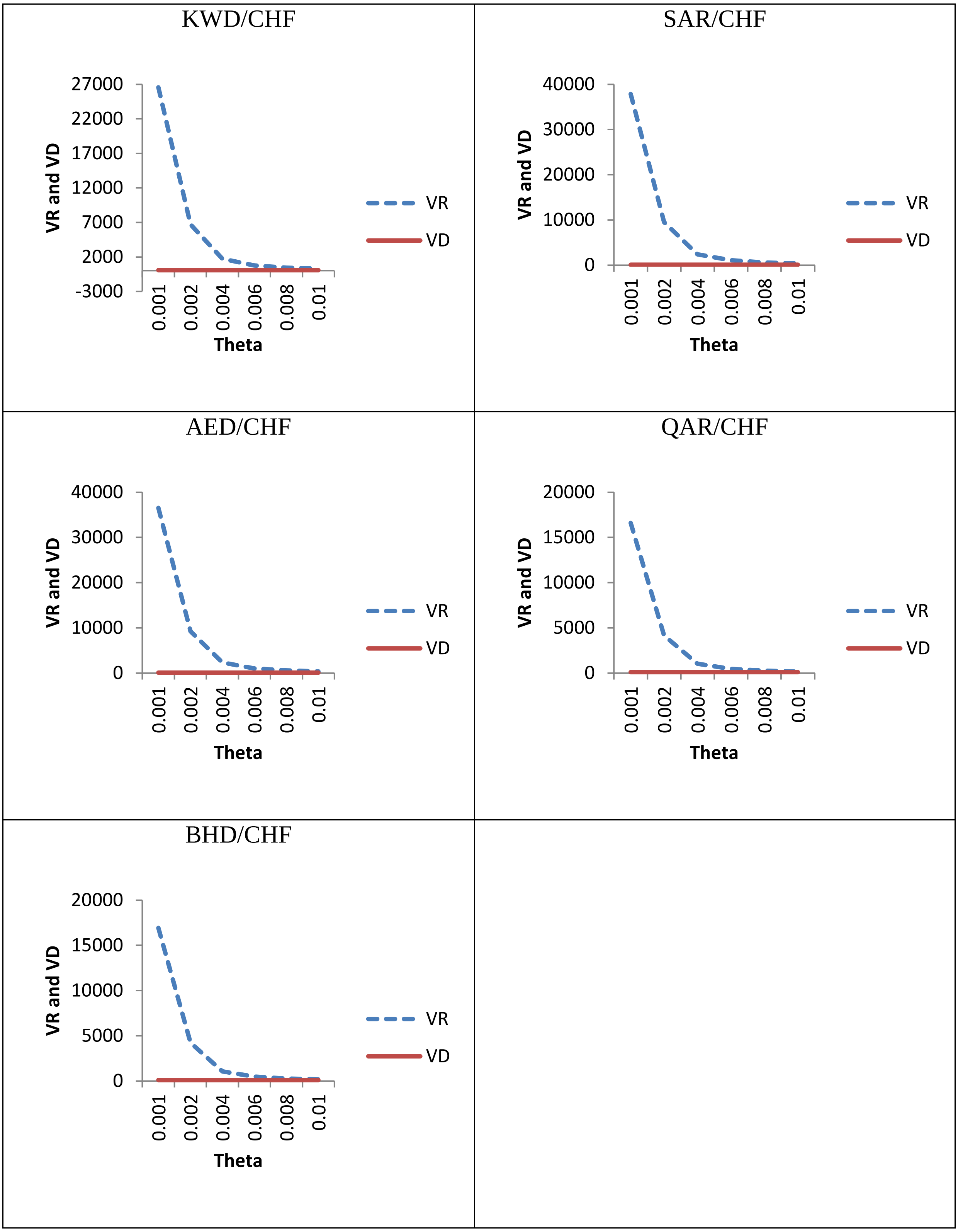


Figure 6.7 VR and VD under HY for GCC Currencies against GBP (equal weights)

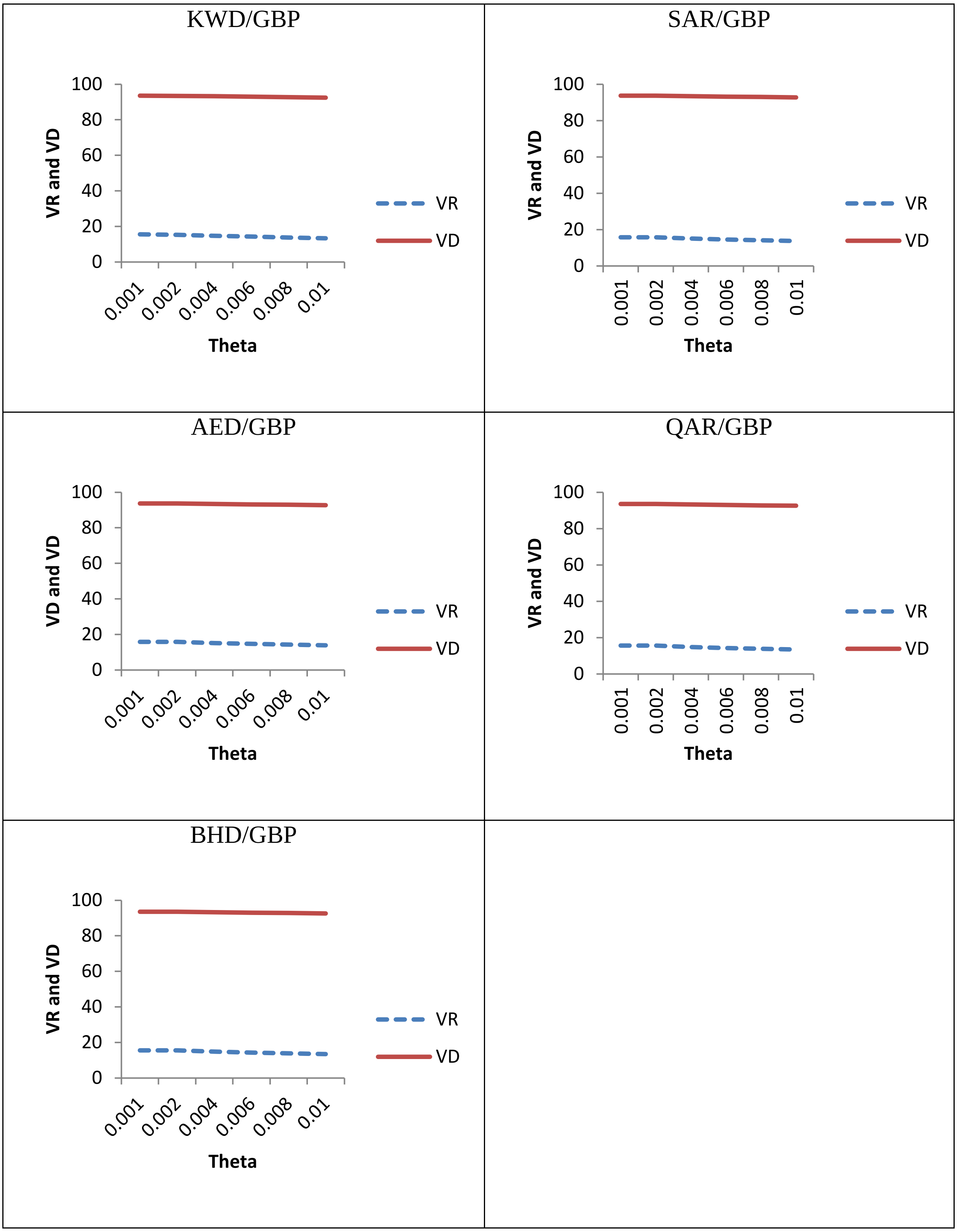


Figure 6.8 VR and VD under HY for GCC Currencies against JPY (equal weights)

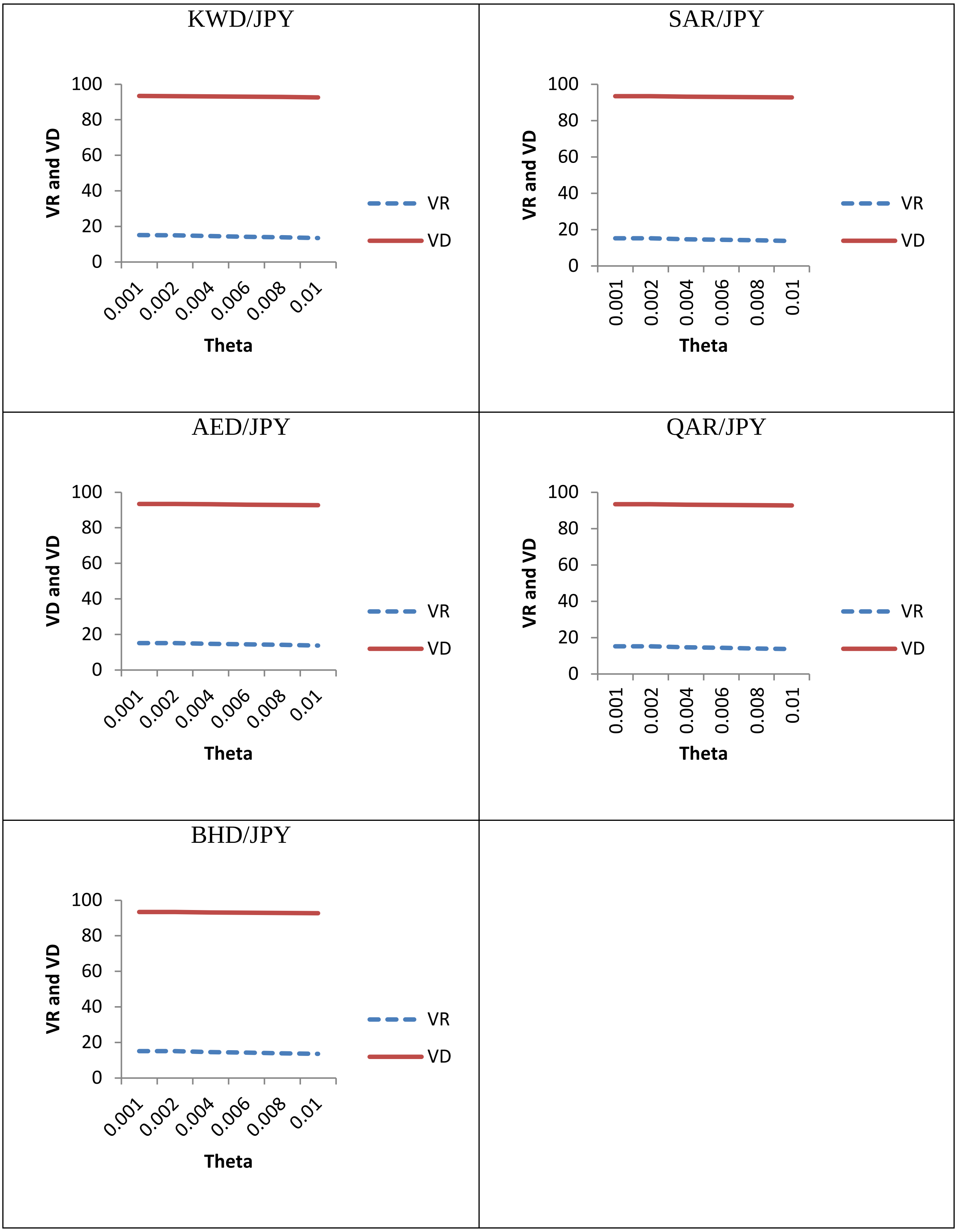


Figure 6.9 VR and VD under HY for GCC Currencies against CHF (equal weights)

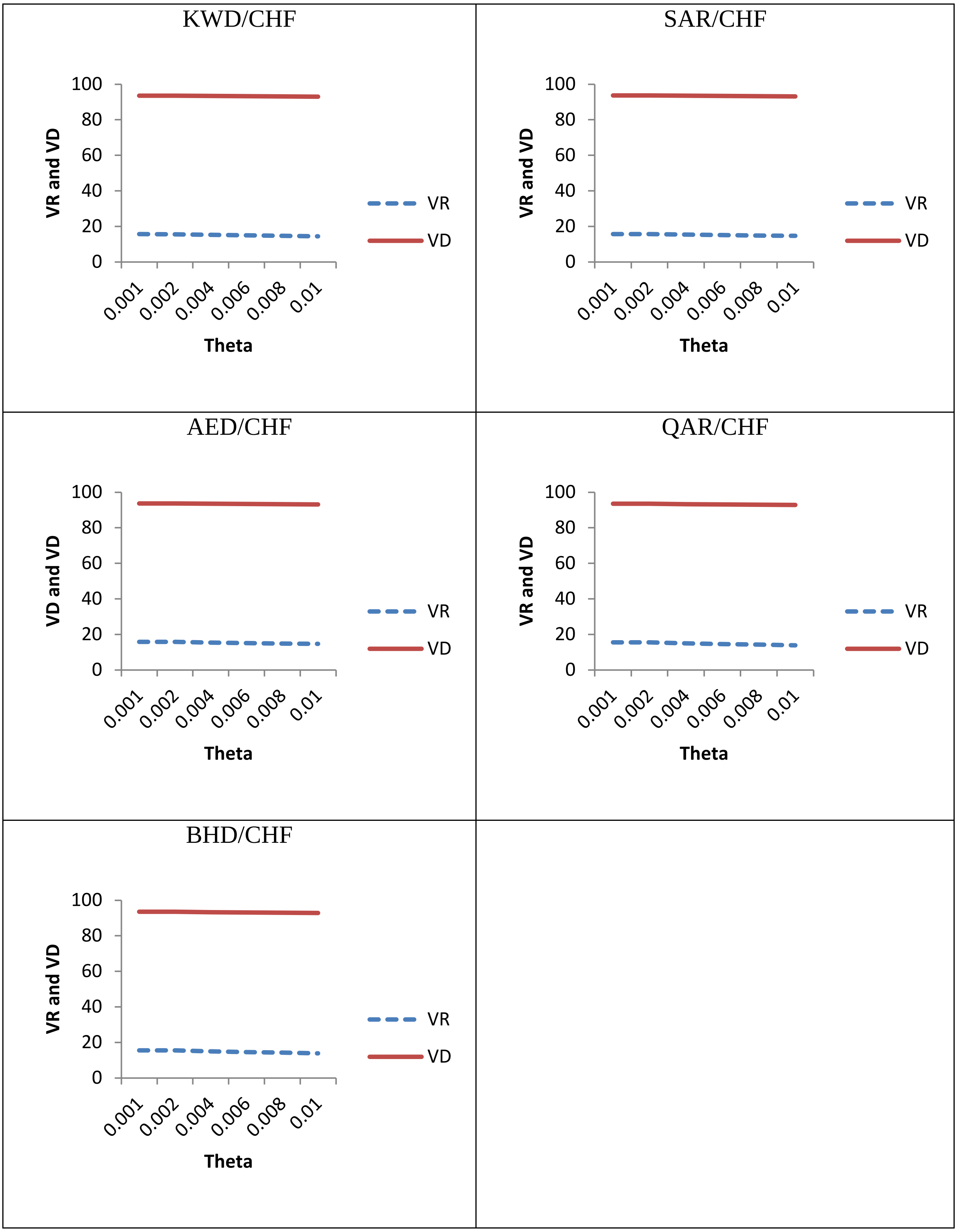


Figure 6.10 V_x for GCC Currencies against GBP over time under RS (θ=.002)

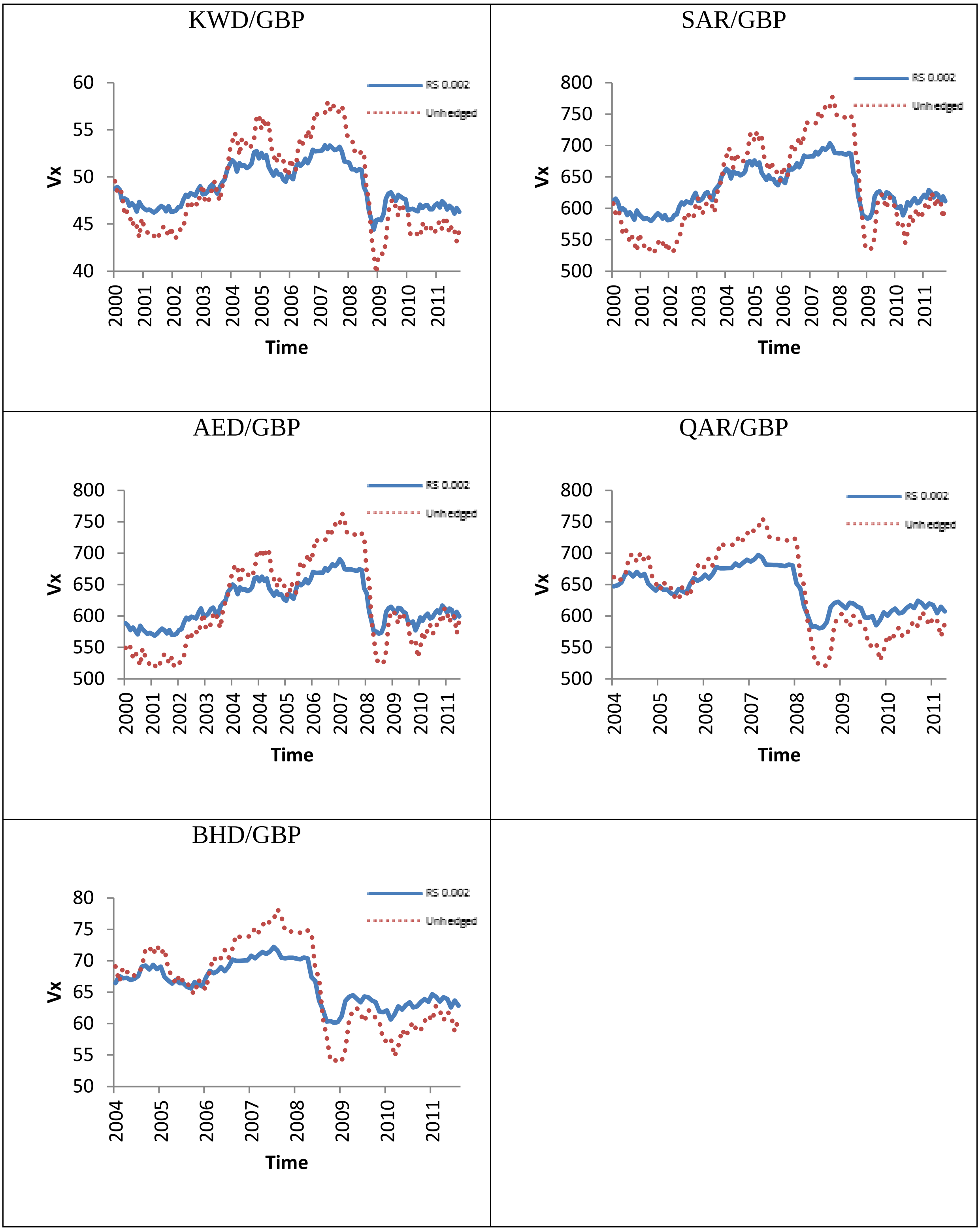


Figure 6.11 V_x for GCC Currencies against JPY over time under RS (θ=.002)

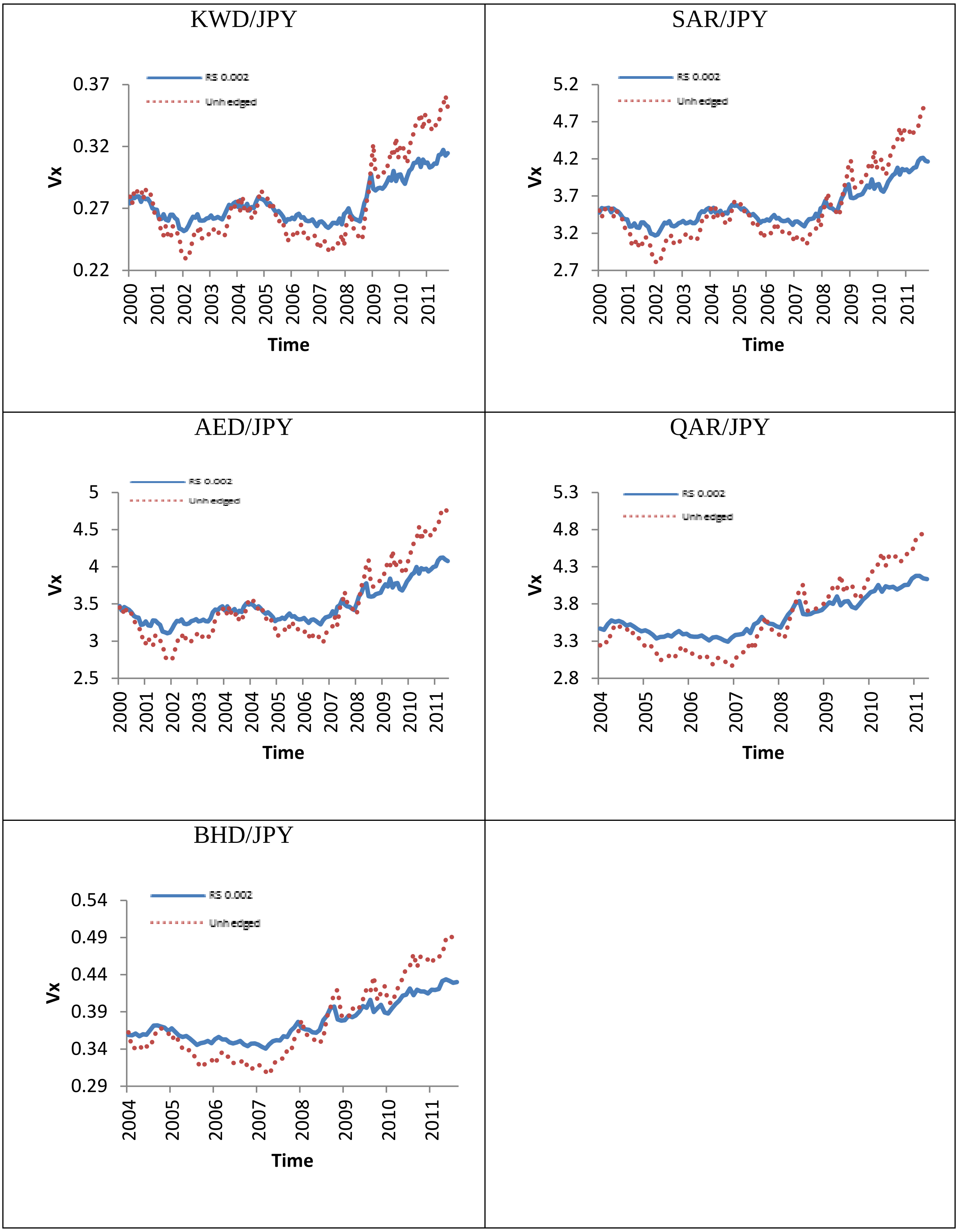


Figure 6.12 V_x for GCC Currencies against CHF over time under RS (θ=.002)

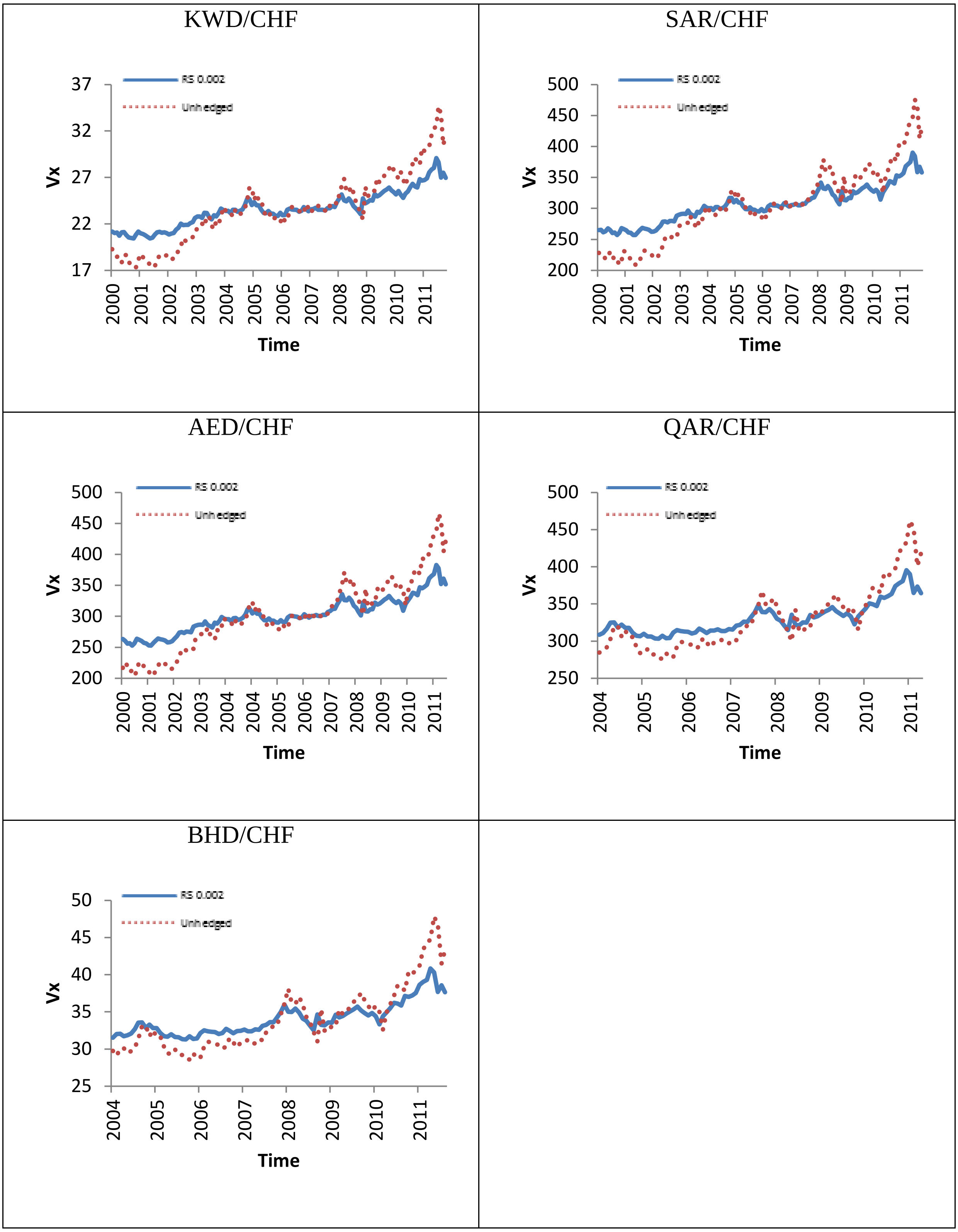


Figure 6.13 V_x for GCC Currencies against GBP over time under CC (θ=.002)

Figure 6.14 V_x for GCC Currencies against JPY over time under CC (θ=.002)

Figure 6.15 V_x for GCC Currencies against CHF over time under CC (θ=.002)

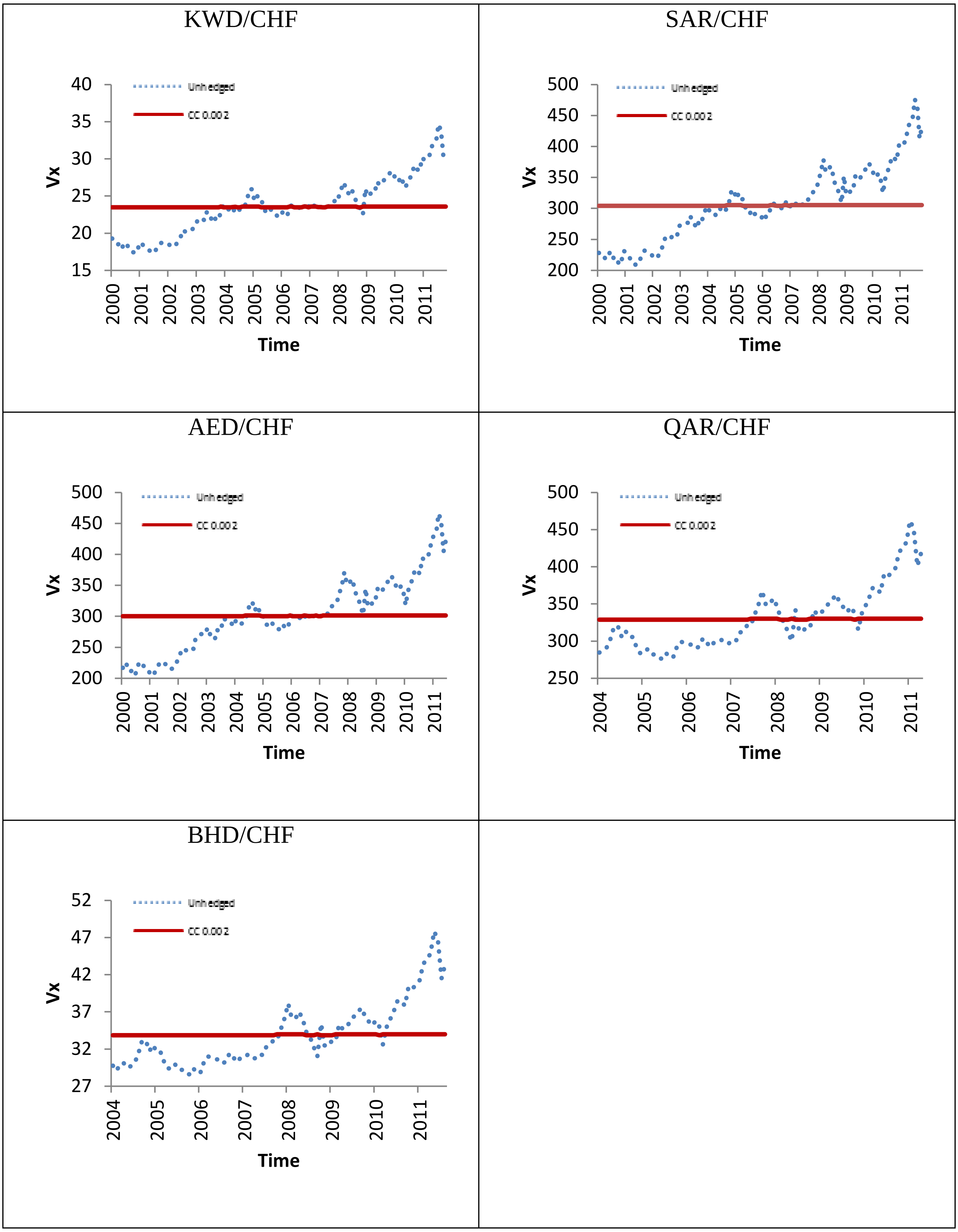


Figure 6.16 V_x for GCC Currencies against GBP under RS, CC, and HY (θ=.01, equal weights for HY)

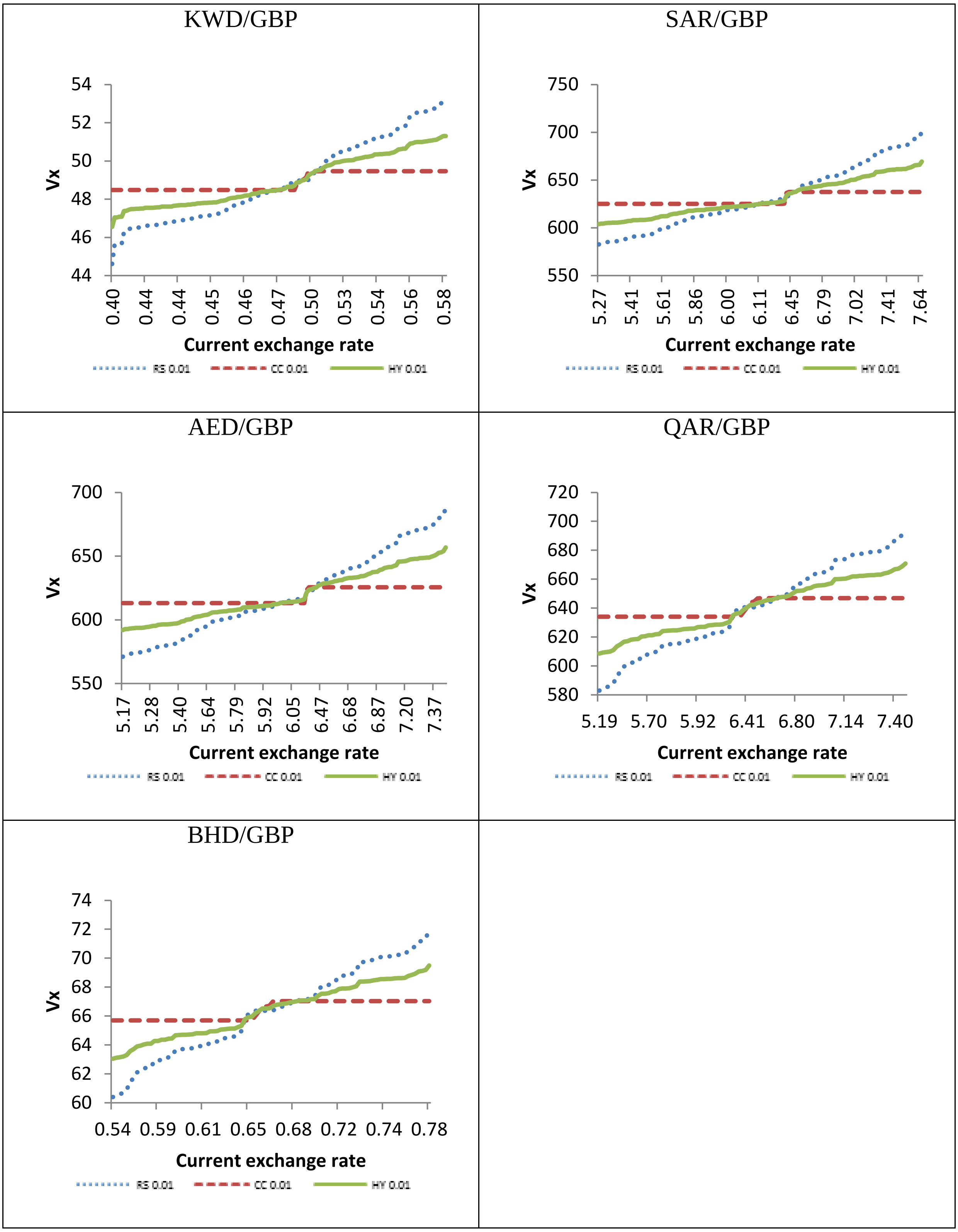


Figure 6.17 V_x for GCC Currencies against JPY under RS, CC, and HY (θ=.01, equal weights for HY)

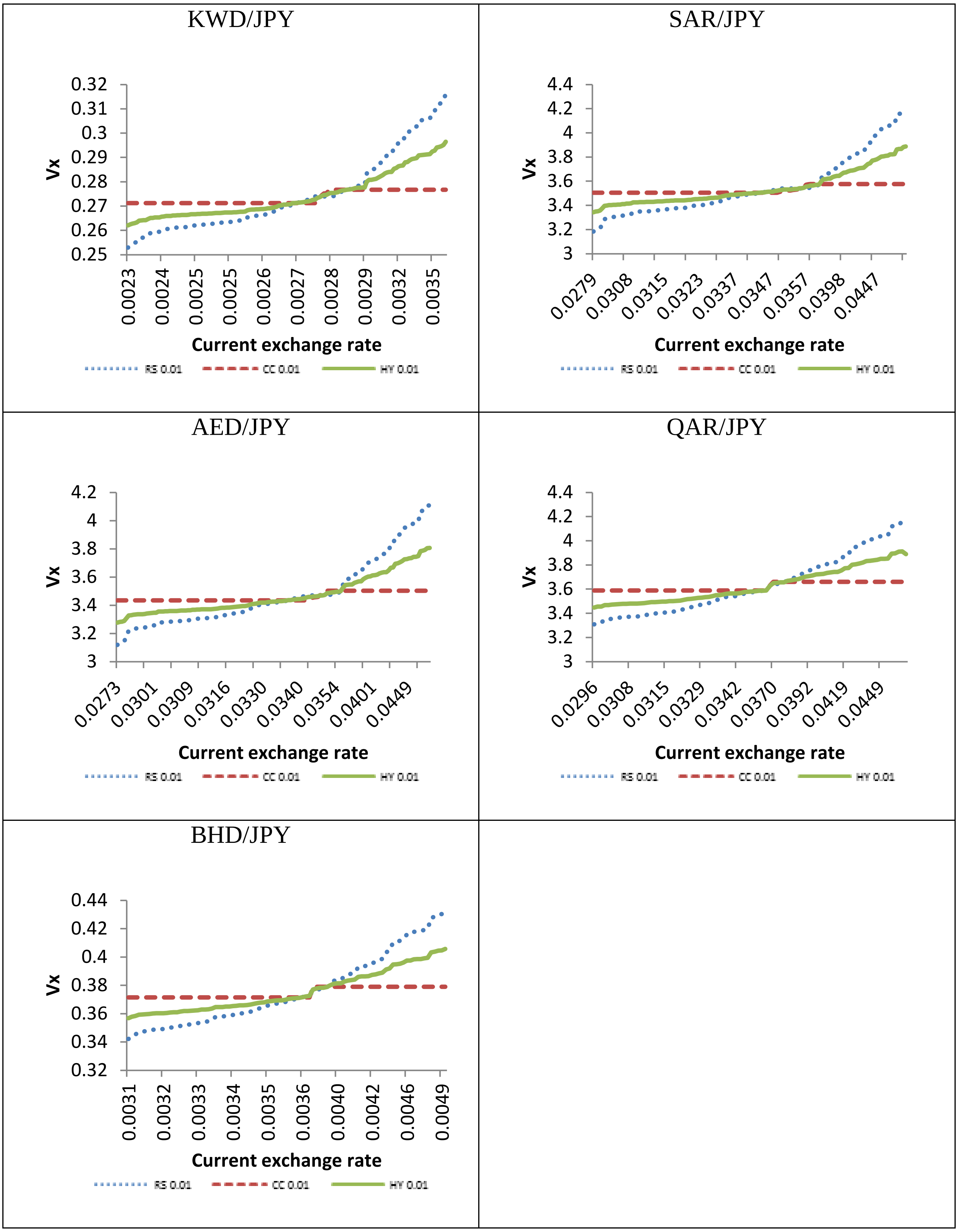


Figure 6.18 V_x for GCC Currencies against CHF under RS, CC, and HY (θ=.01, equal weights for HY)

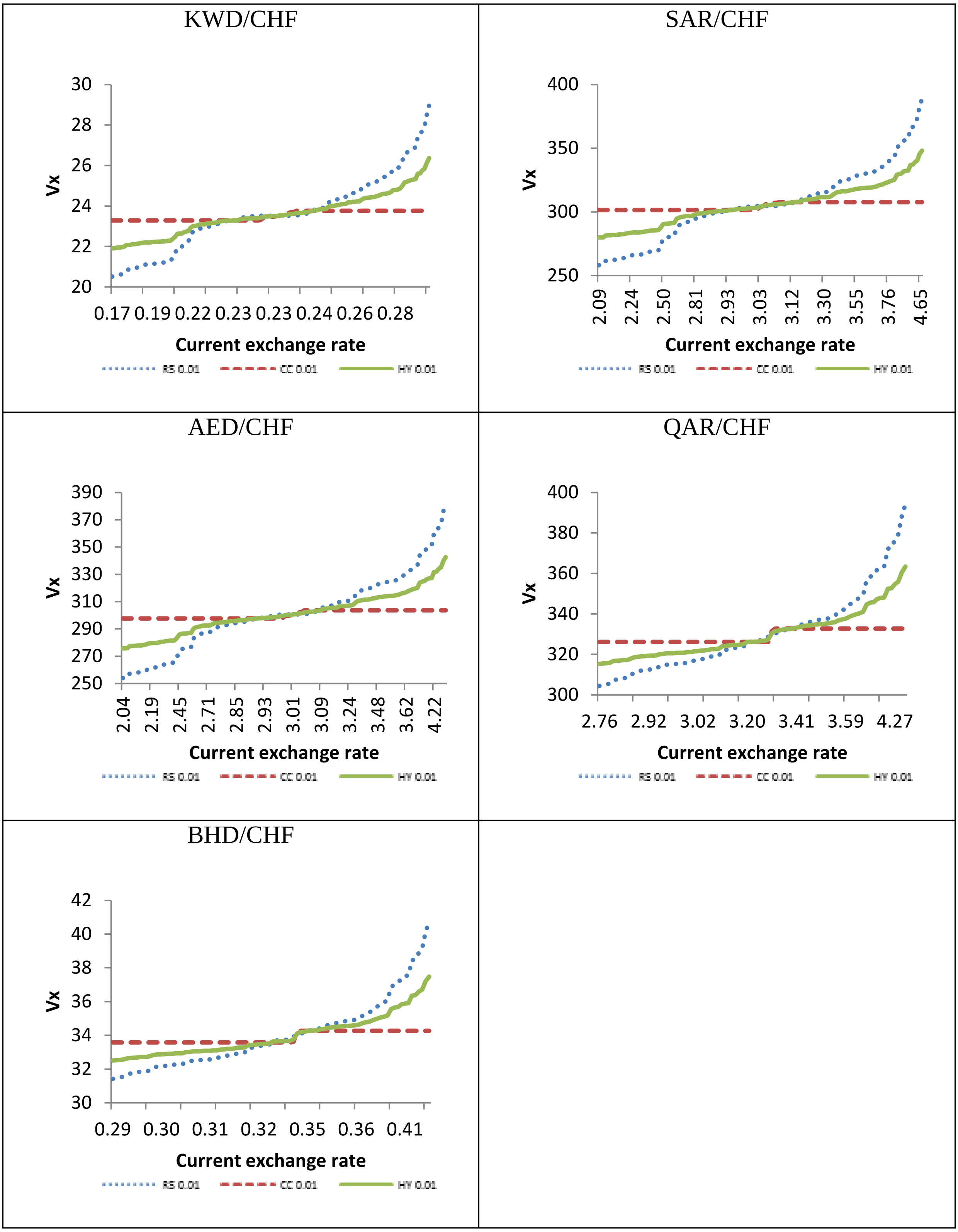


Figure 6.19 VD for GCC Currencies against GBP under RS, CC, and HY (different θ, HY equal weights)

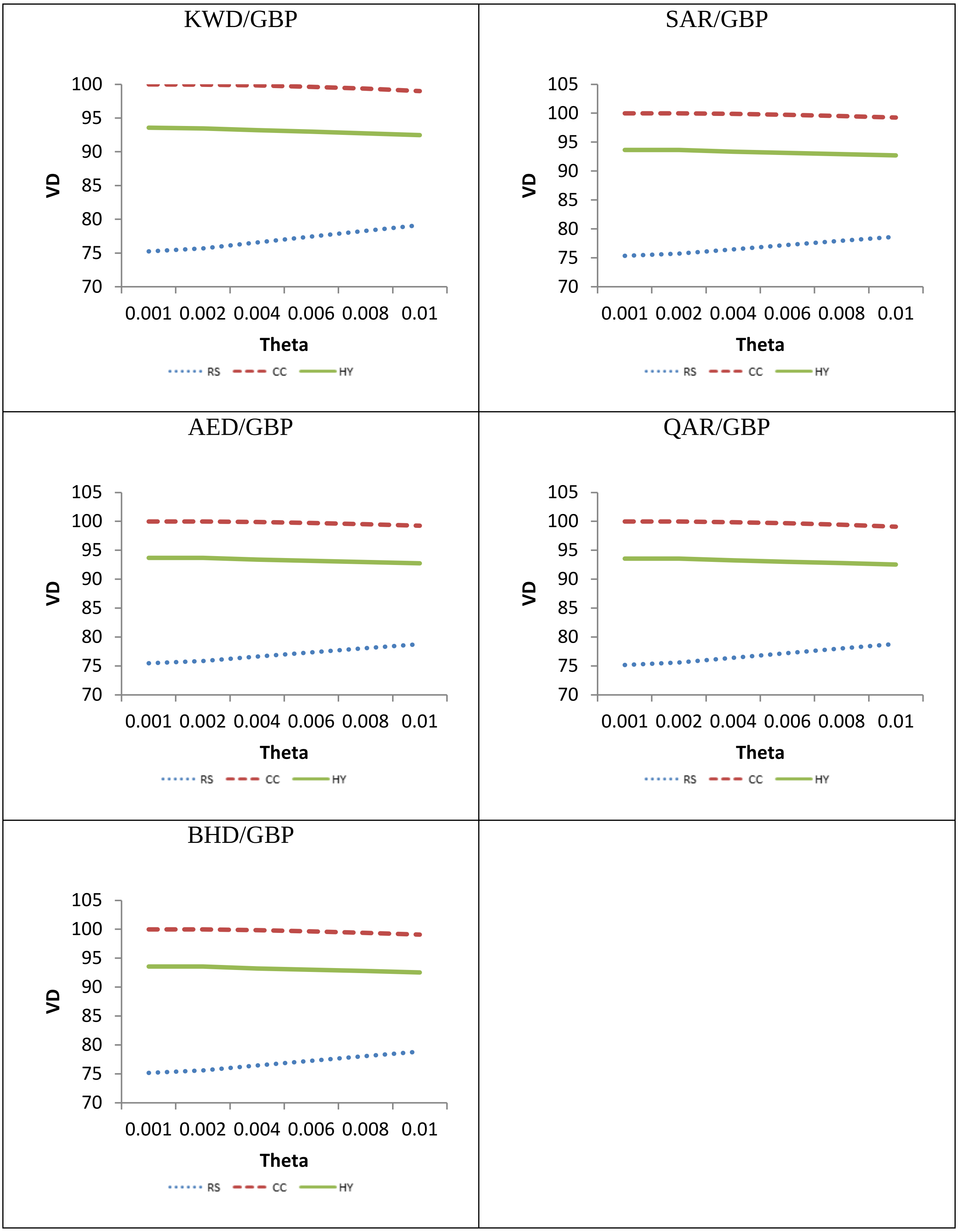


Figure 6.20 VD for GCC Currencies against JPY under RS, CC, and HY (different θ, HY equal weights)

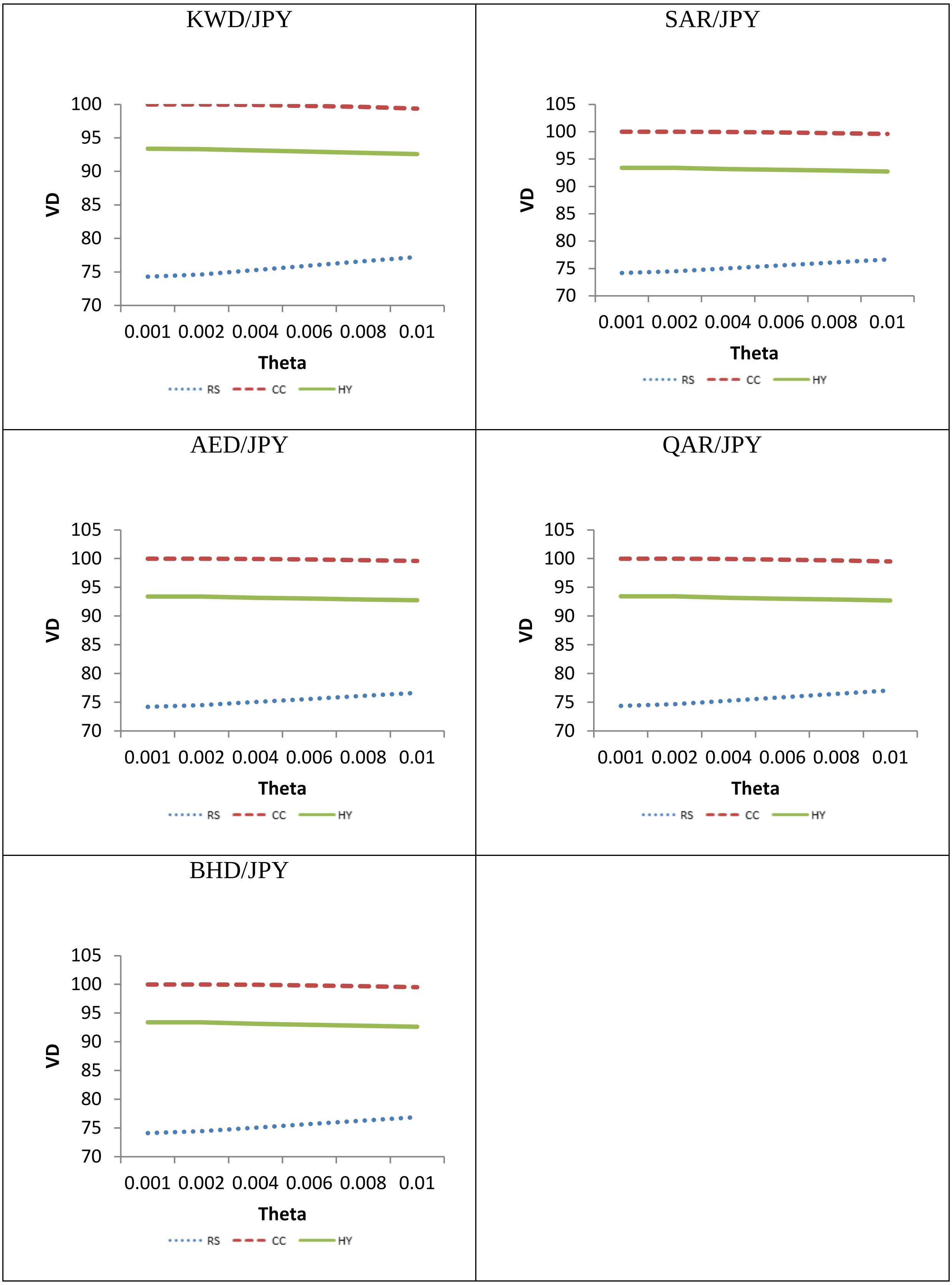


Figure 6.21 VD for GCC Currencies against CHF under RS, CC, and HY (different θ, HY equal weights)

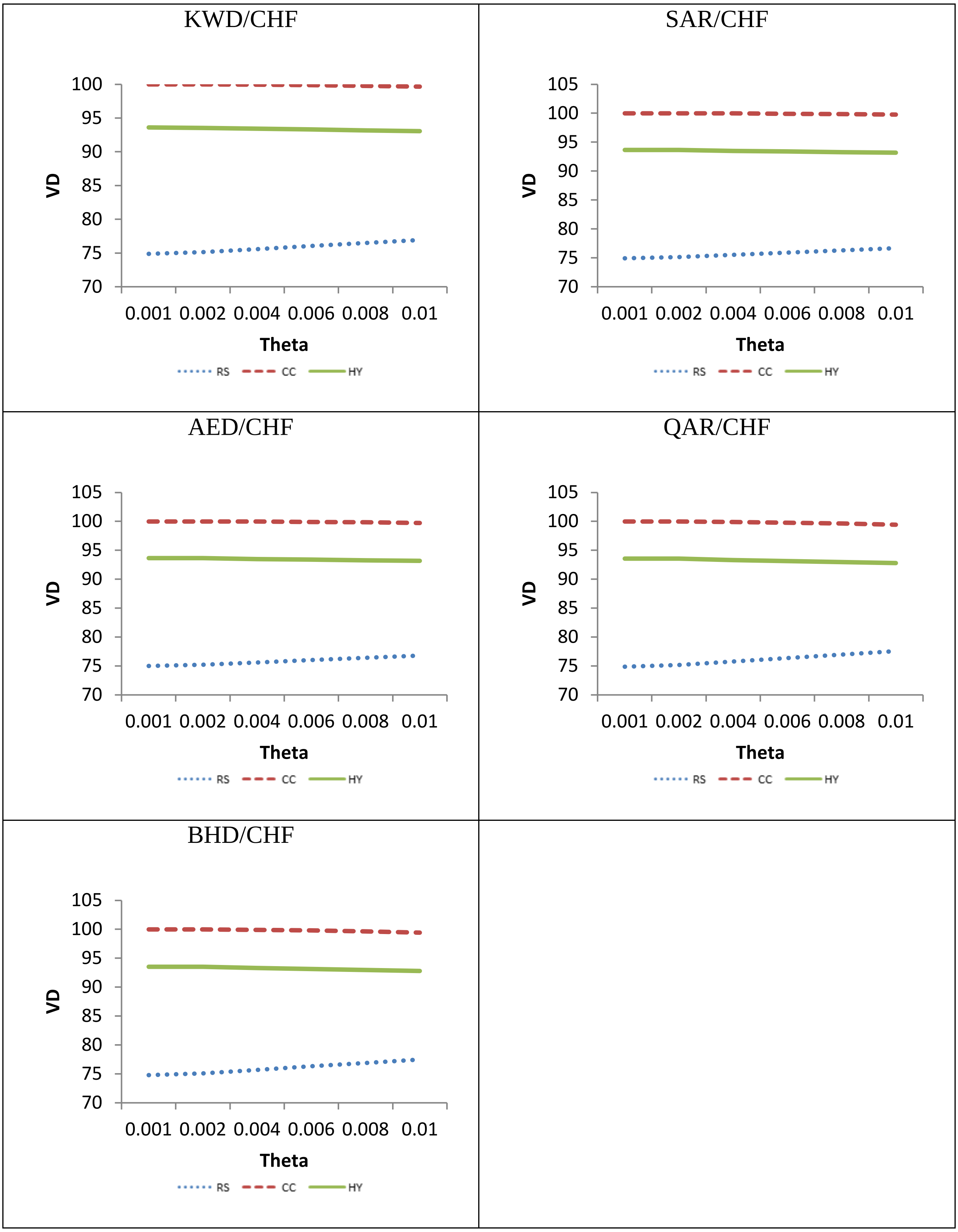


Figure 6.22 Var.(V_x) for GCC Currencies against GBP under RS, CC, and HY (different θ, HY equal weights)

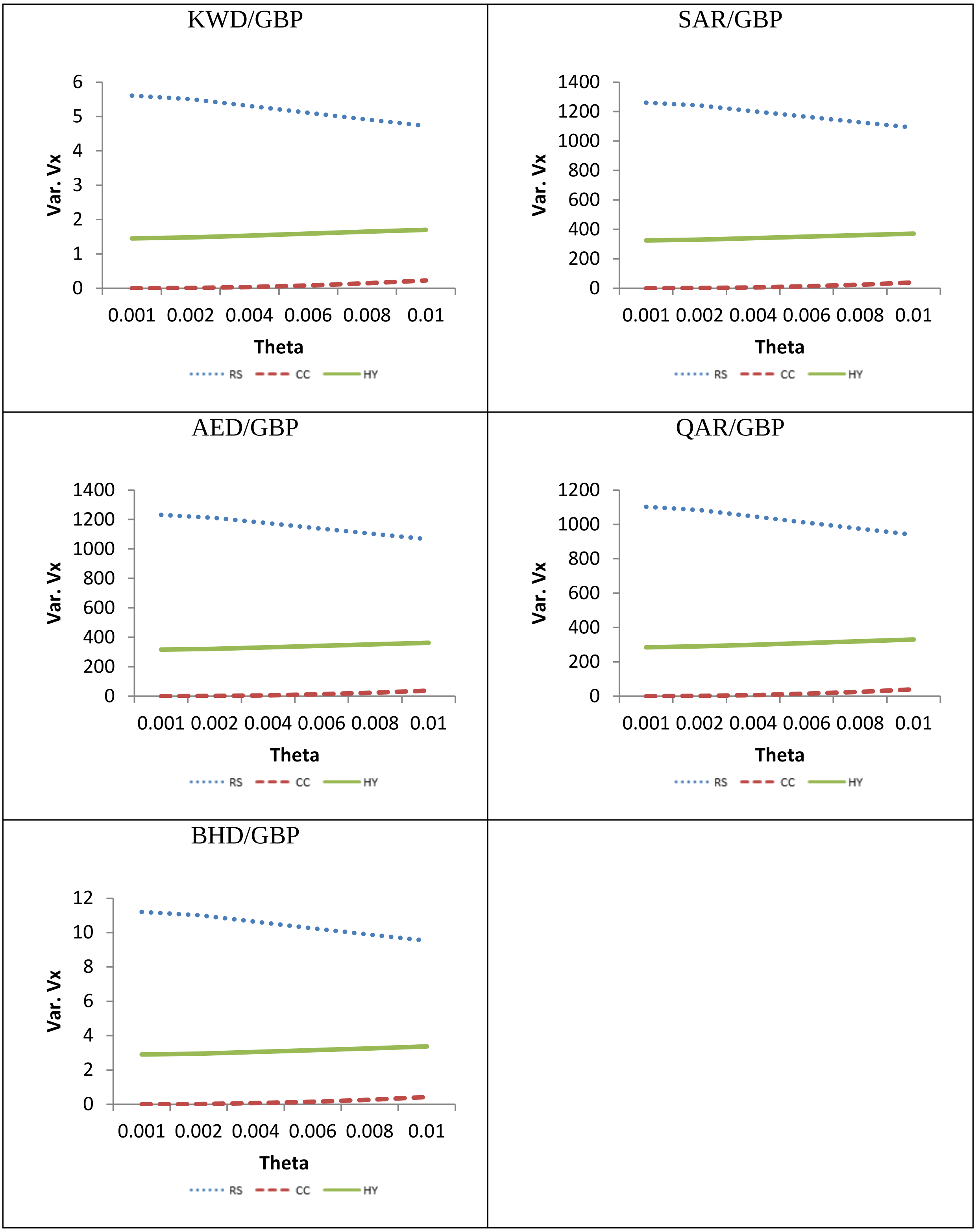


Figure 6.23 Var.(V_x) for GCC Currencies against JPY under RS, CC, and HY (different θ, HY equal weights)

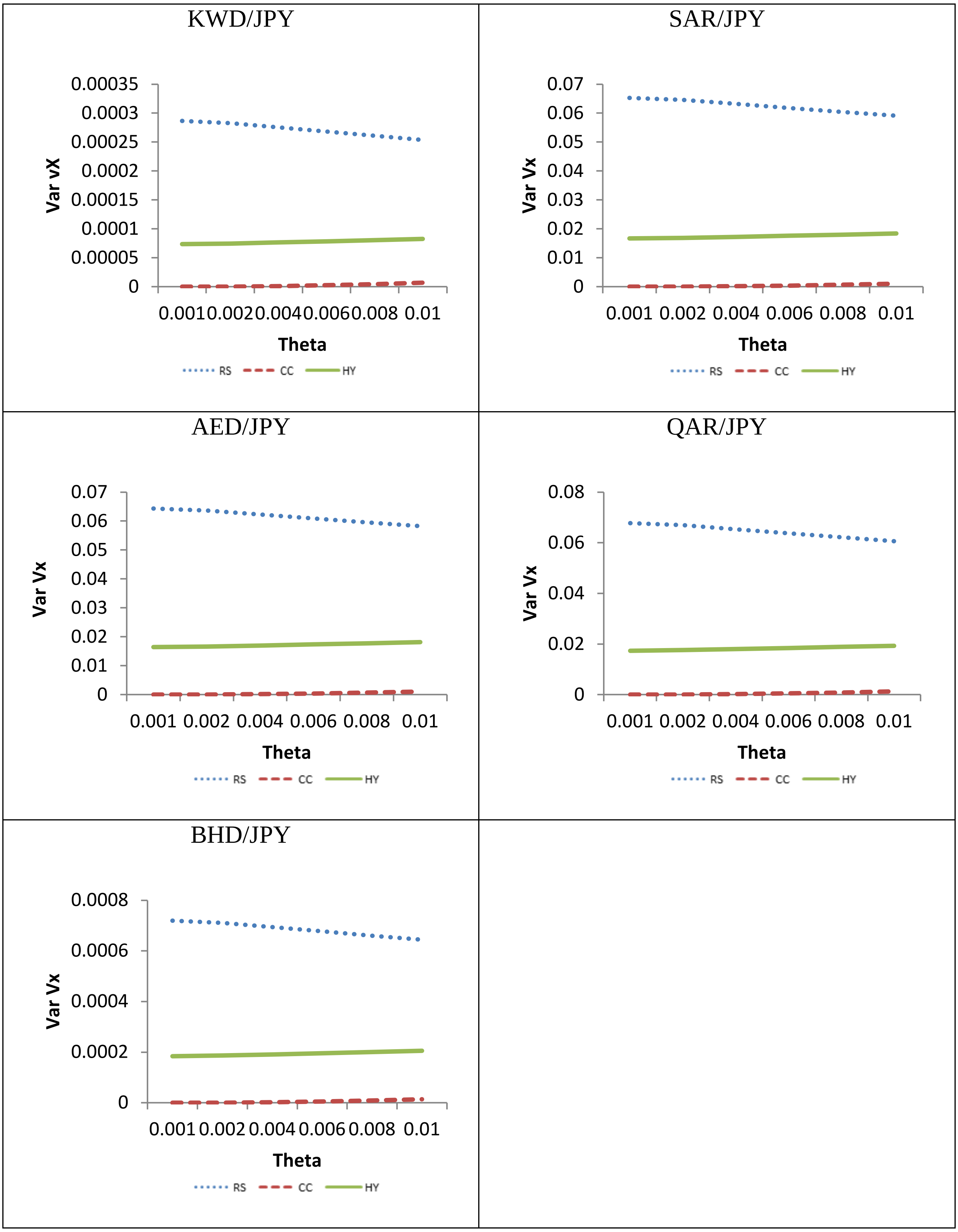


Figure 6.24 Var. (V_x) for GCC Currencies against CHF under RS, CC, and HY (different θ, HY equal weights)

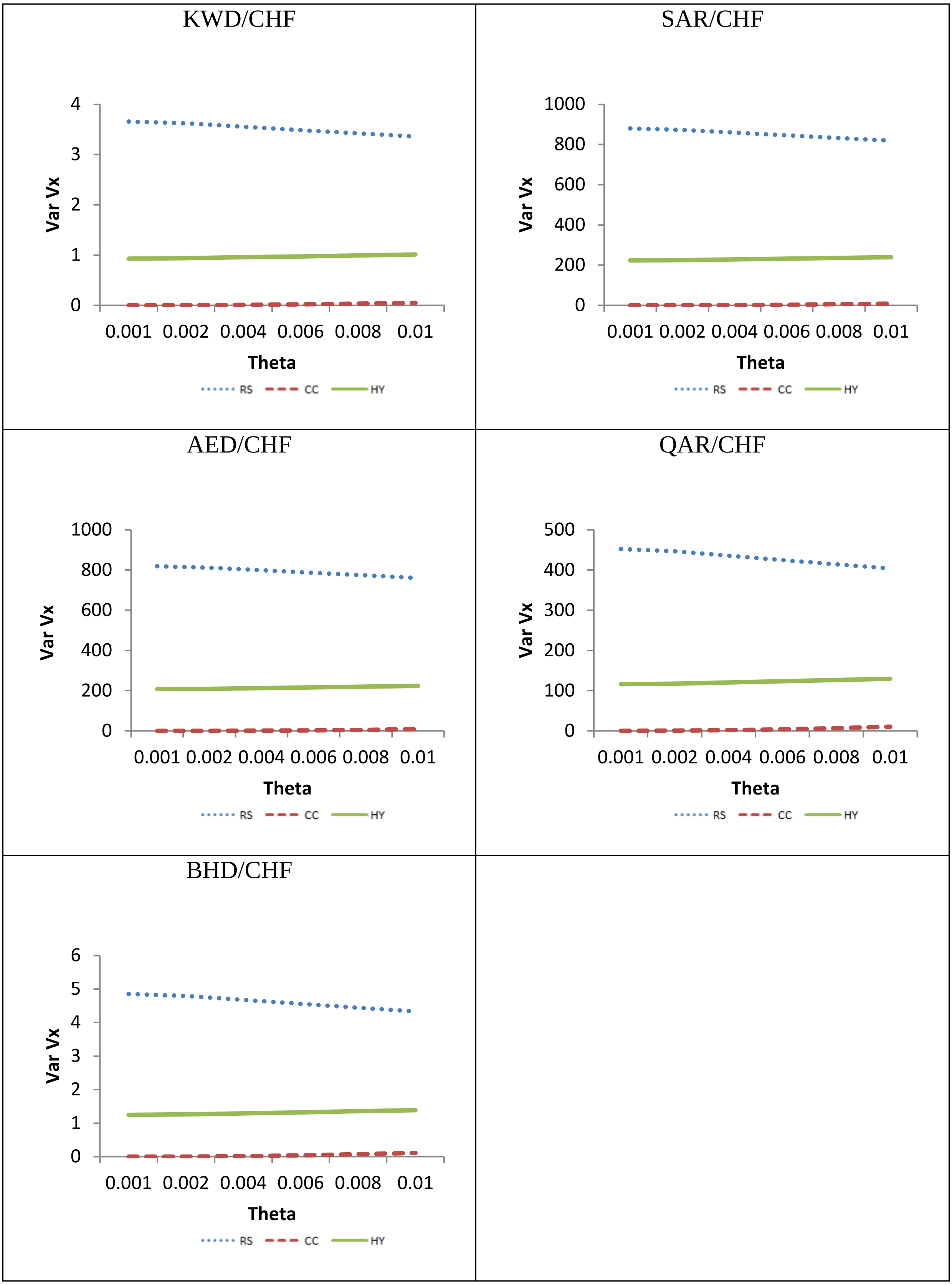


Figure 6.25 V_x (Max) for GCC Currencies against GBP under RS, CC, and HY (different θ, HY different weights)

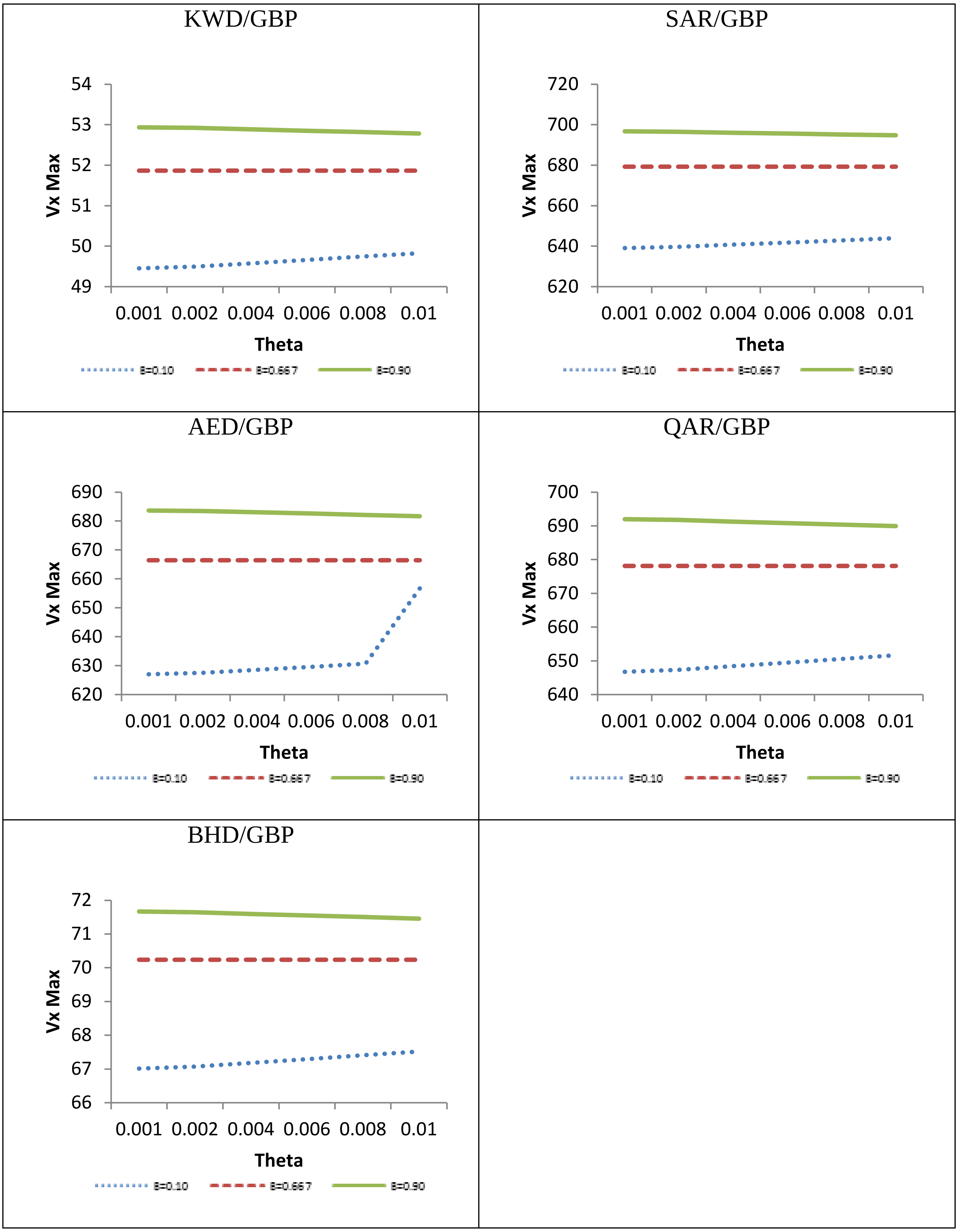


Figure 6.26 V_x (Max) for GCC Currencies against JPY under RS, CC, and HY (different θ, HY different weights)

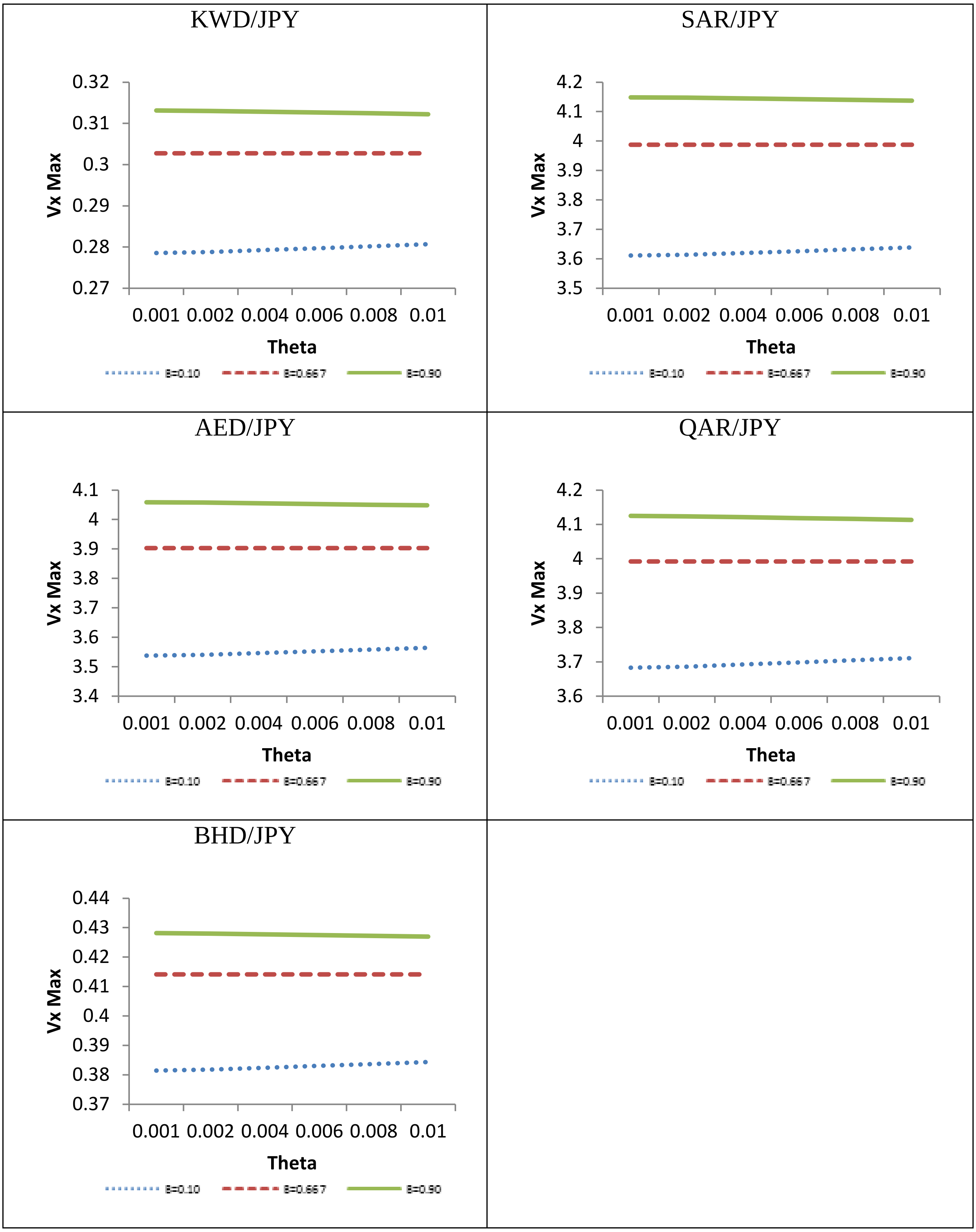


Figure 6.27 V_x (Max) for GCC Currencies against CHF under RS, CC, and HY (different θ, HY different weights)

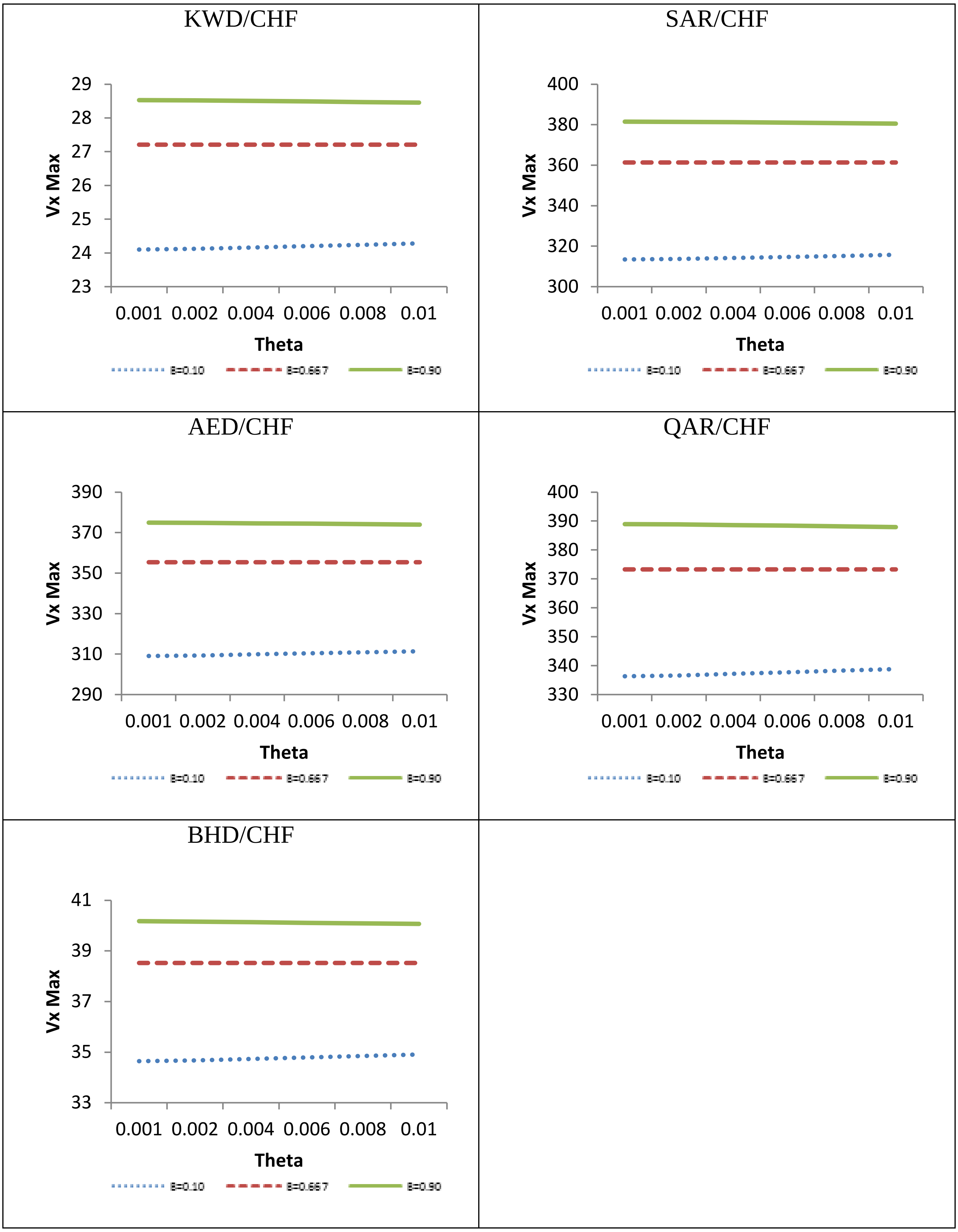


Figure 6.28 Var. V_x for GCC Currencies against GBP under HY (different θ, different weights)

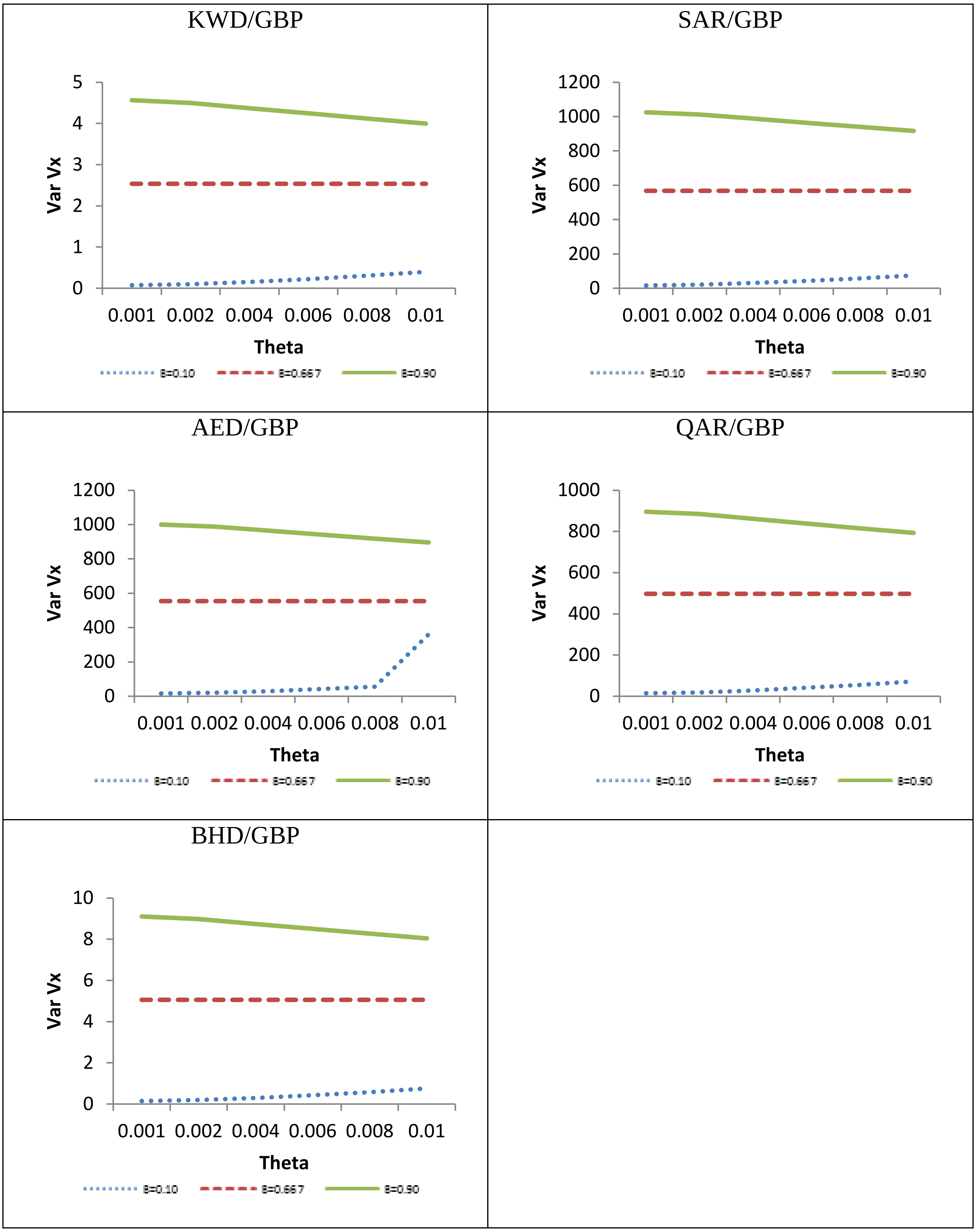


Figure 6.29 Var. V_x for GCC Currencies against JPY under HY (different θ, different weights)

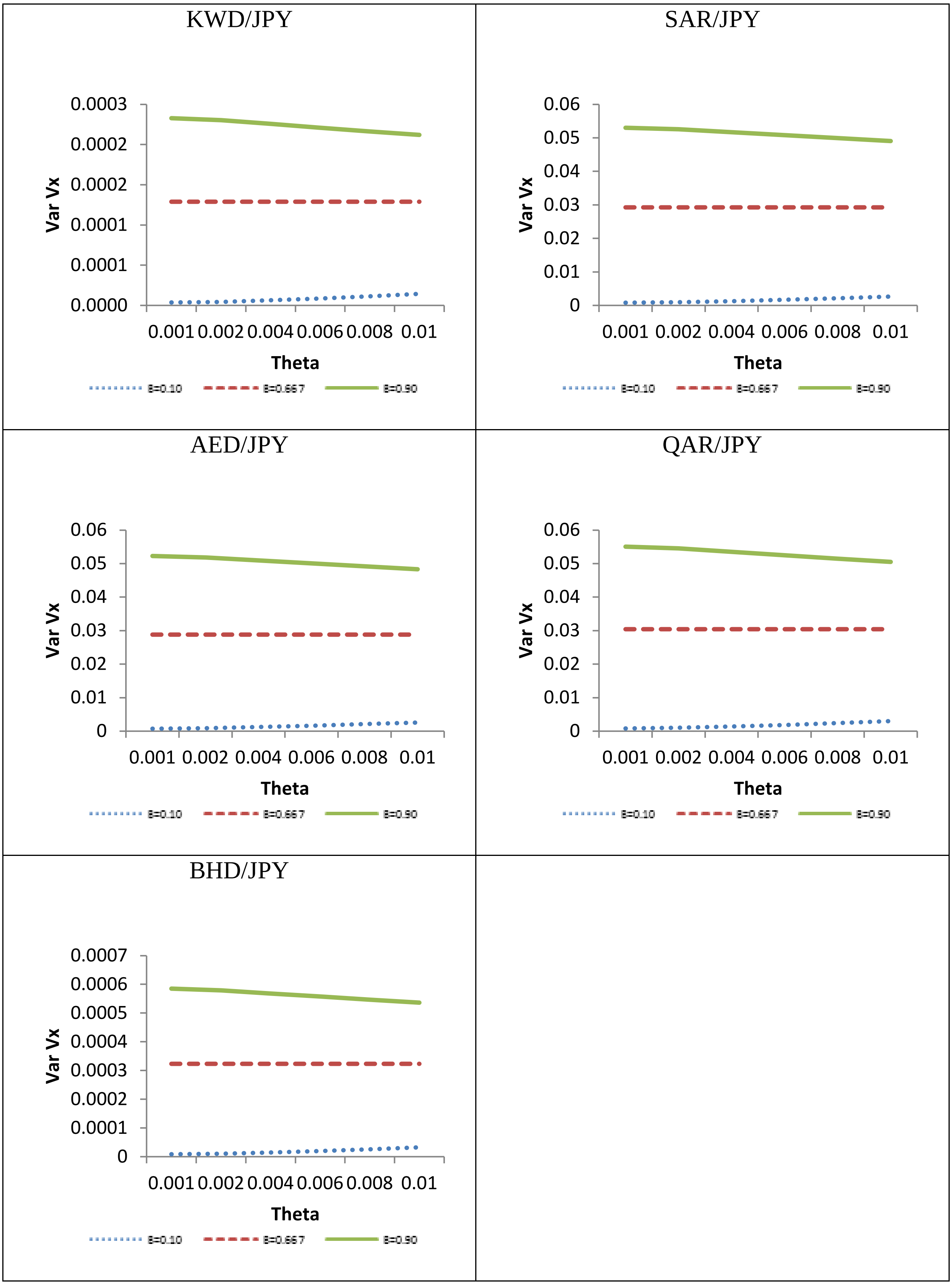


Figure 6.30 Var. V_x for GCC Currencies against CHF under HY (different θ, different weights)

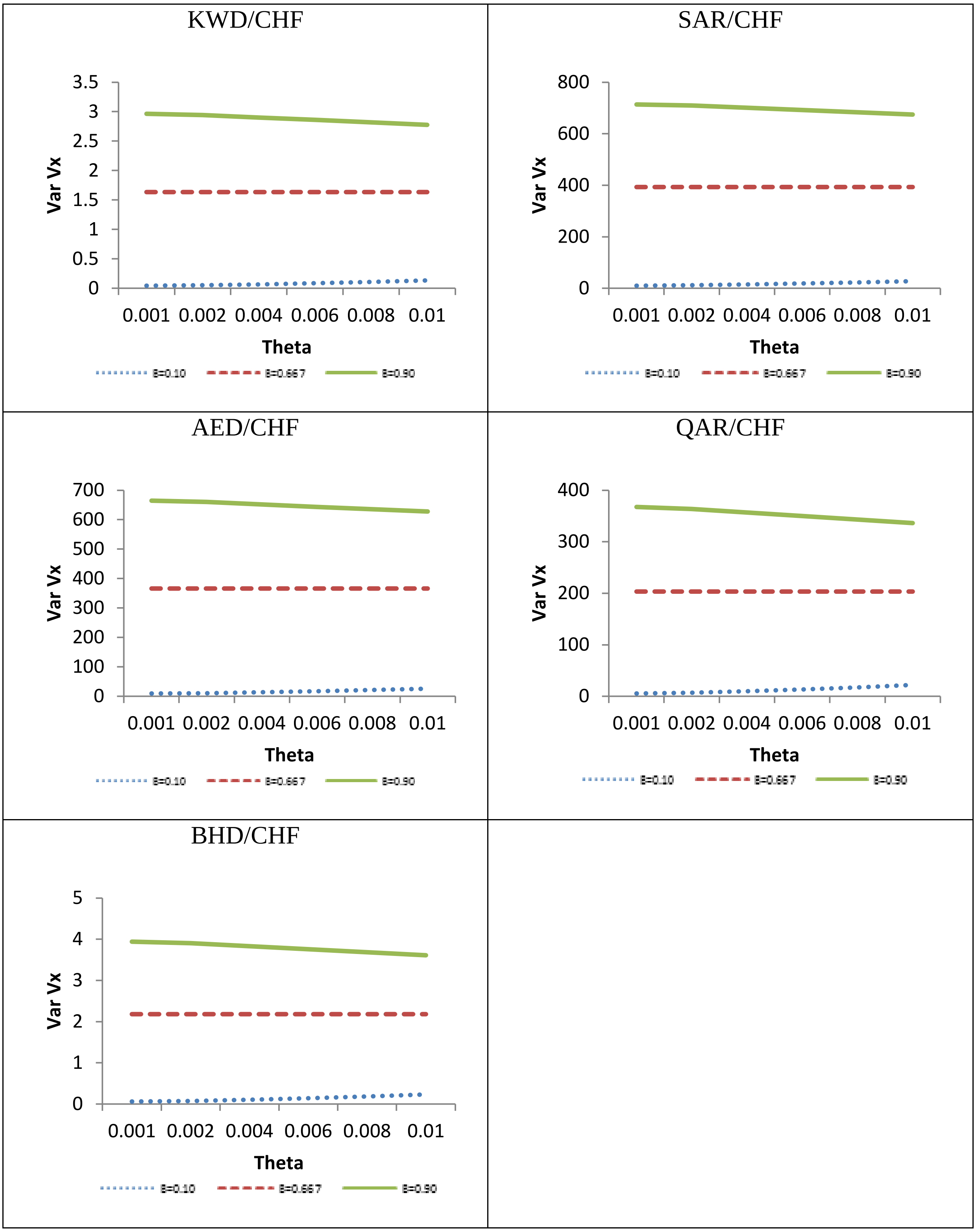


Figure 6.31 VR for GCC Currencies against GBP under HY (different θ, different weights)

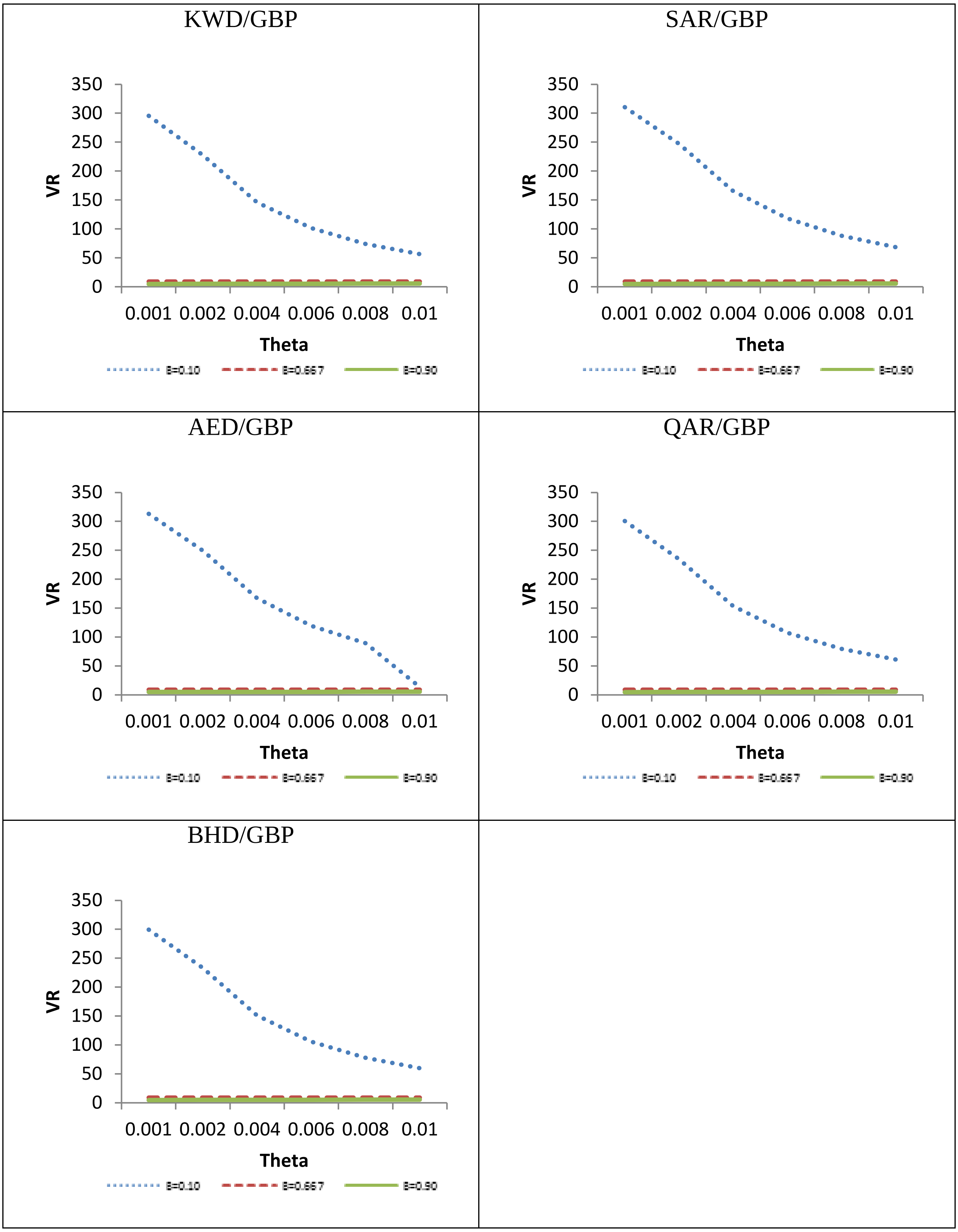


Figure 6.32 VR for GCC Currencies against JPY under HY (different θ, different weights)

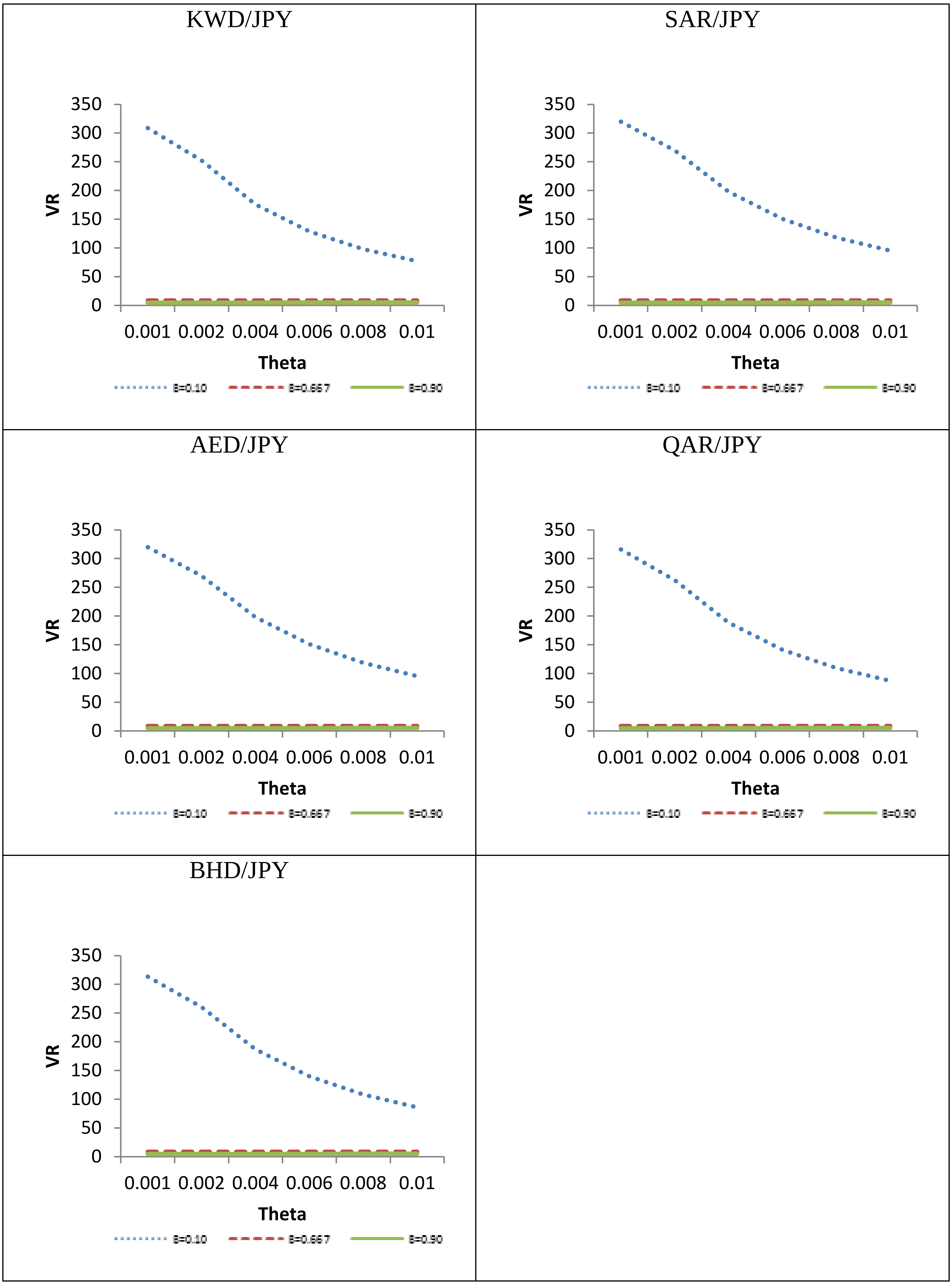


Figure 6.33 VR for GCC Currencies against CHF under HY (different θ, different weights)

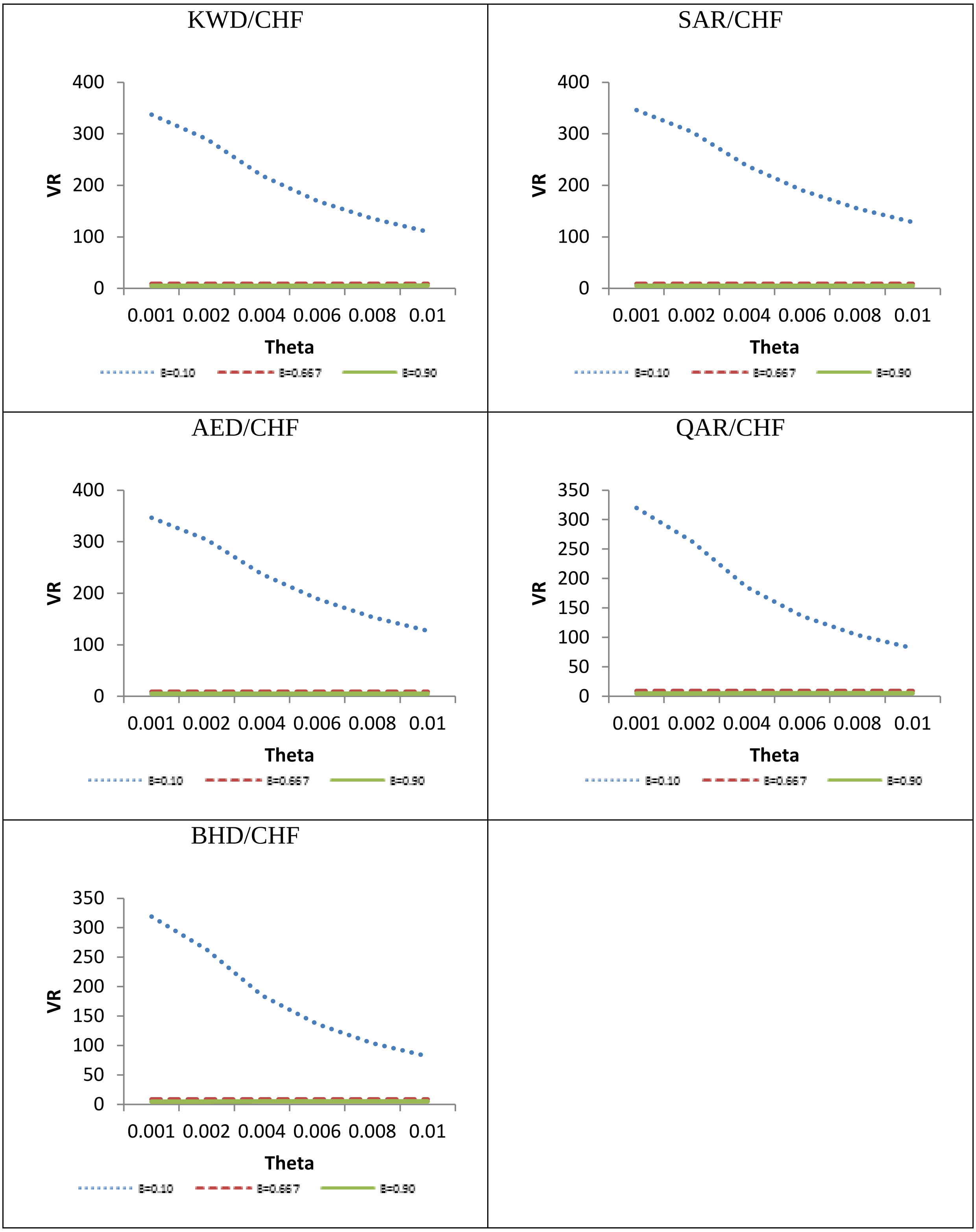


Figure 6.34 VD for GCC Currencies against GBP under HY (different θ, different weights)

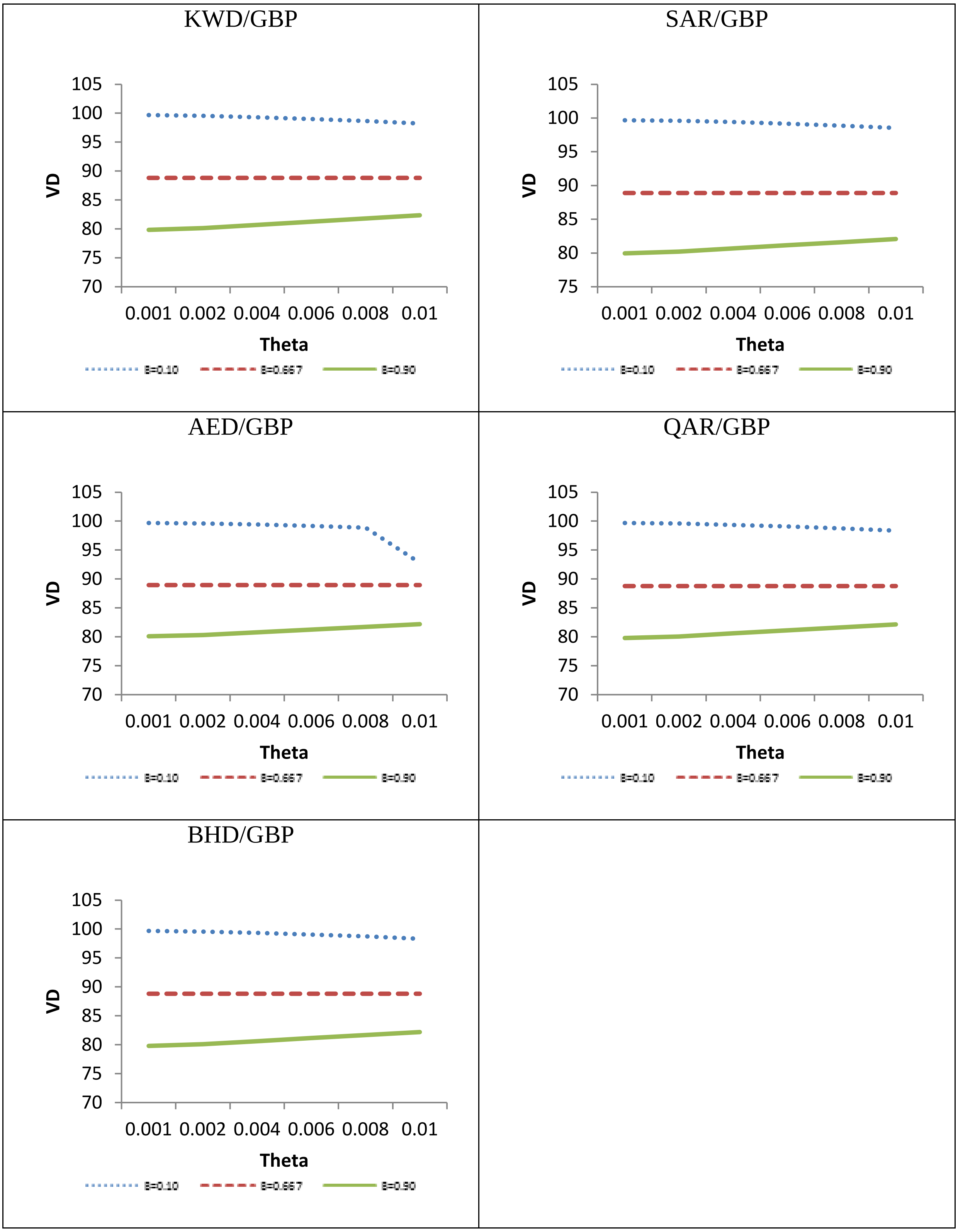


Figure 6.35 VD for GCC Currencies against JPY under HY (different θ, different weights)

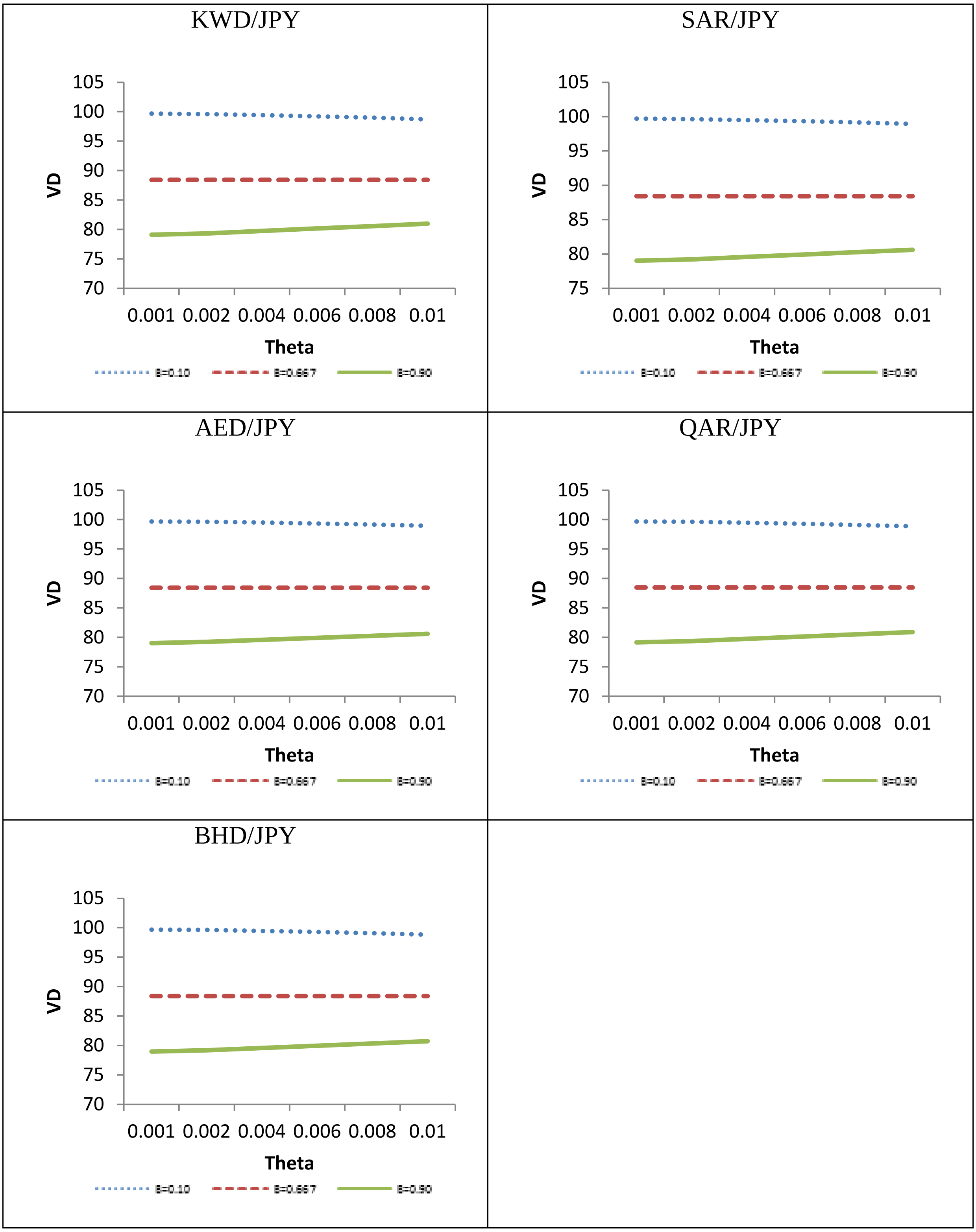
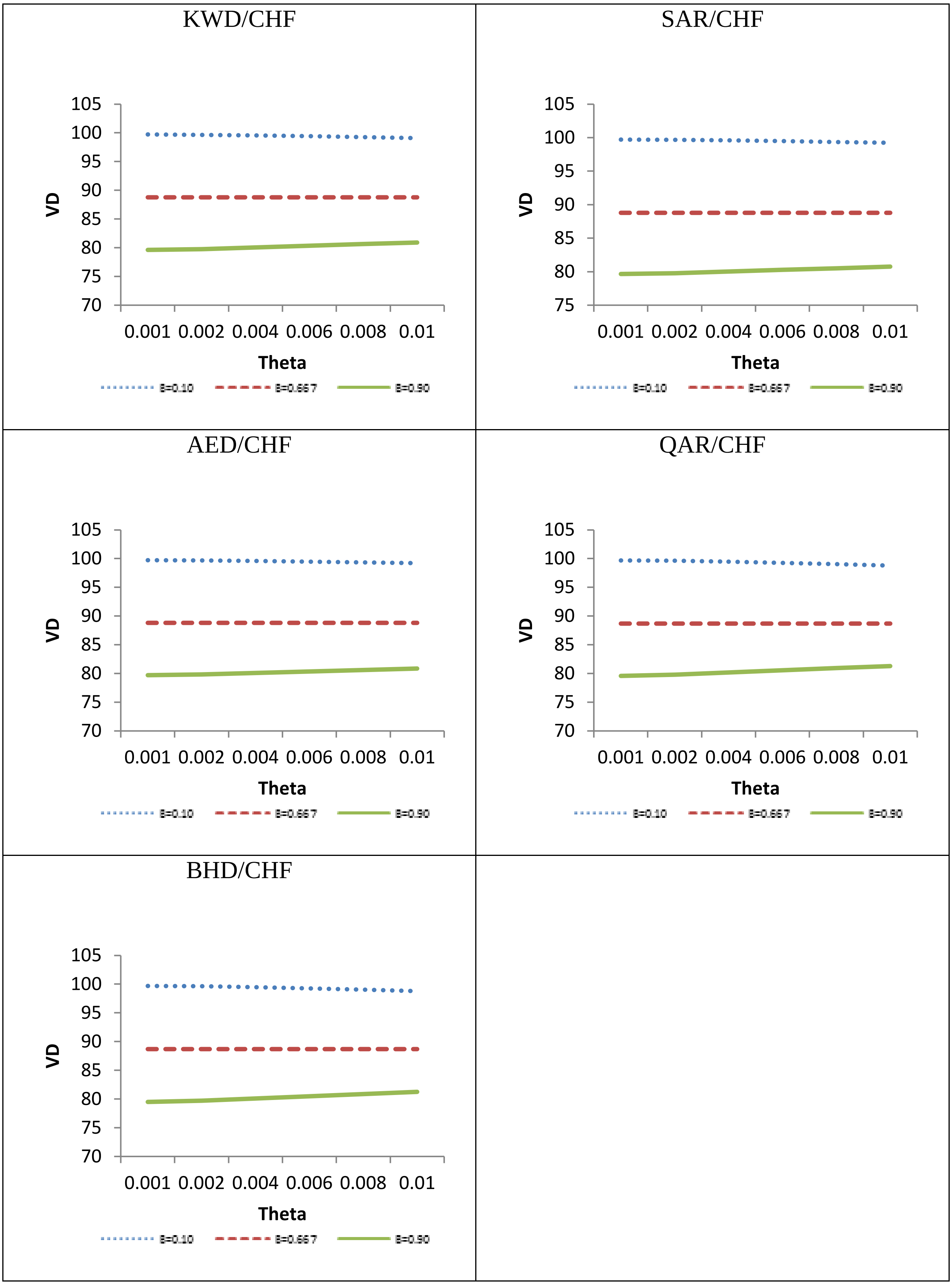


Figure 6.36 VD for GCC Currencies against CHF under HY (different θ, different weights)



CHAPTER SEVEN

MEASURING THE HEDGE RATIO

7.1 Introduction

In the previous chapters, we estimated the hedge ratio using the OLS estimation method. However, in the financial-econometrics literature, there are many other estimation methods that can be used to estimate the hedge ratio empirically. In this chapter, we examine the effectiveness of minimising the variance of the hedge ratio using different econometric models for the GCC currencies under money-market hedging and cross-currency hedging. The aim of this examination is to determine whether different model specifications and estimation methods yield different hedge-effectiveness results. In other words, does the sophistication of the model improve the effectiveness of the hedge? Our results show that these econometric models fail either to add value or to improve the effectiveness of the hedge. This chapter starts with a literature review in Section 7.2, followed by discussion of the data and methodology in Section 7.3, results and analysis are in Section 7.4 and the conclusion is in Section 7.5.

7.2 Literature Review

Firms that are involved in international-business transactions should always employ the best model to estimate the optimal hedge ratio. A perfect hedge in which the loss (profit) in the unhedged position is completely offset by the profit (loss) in the hedged position may not occur in real-life situations.[11] Therefore, firms will have greater concern about minimising

[11] In principle, it is possible to obtain a perfect hedge if the prices of two positions are perfectly correlated and the optimal hedge ratio (in this case a hedge ratio of 1) is used. In practice firms are not entirely risk averse, in which case they do not use a hedge ratio of 1, which means that the hedge is not perfect.

the variance of the rate of return in the hedged position to avoid the adverse effect of exchange-rate changes. The estimation of a minimum-variance hedge ratio depends on the econometric model employed to estimate it (Ghosh, 1993). According to Wang *et al.* (2015), given that numerous sophisticated estimation methods have been utilised aside from OLS estimation to estimate the hedge ratio, the best estimation method is still unclear. However, Lence (1995), Lien *et al.* (2002), and Moosa (2011a) find that using a simple econometric model to estimate the hedge ratio can provide similar results to those obtained with sophisticated ones. Alexander and Barbosa (2007) find that neither a complex model (such as time-varying conditional covariance), nor the error-correction model (ECM) can outperform the simple OLS model. Copeland and Zhu (2006) and Alexander and Barbosa (2007) also argue that there is no value added when using a sophisticated model to estimate the hedge ratio compared with simple OLS. In fact, according to Moosa (2003a), the success and failure of estimating hedging effectiveness depends on the correlation between the price of the unhedged position and the price of the hedged instrument, not on model specifications.

According to Ederington (1979), the relationship between cash price and future price is represented by a regression model, and a slope coefficient represents the hedge ratio with the objective of minimising the risk of the portfolio (risk-minimising hedge ratio). From a theoretical point of view, this optimal hedge ratio with the objective of minimising the variance of the hedged portfolio is a form of an expected-utility maximisation framework (Johnson, 1960; Ederington, 1979; Myers and Thompson, 1989, Lien and Tse, 2002). This minimum-variance framework is widely used because it is simple to compute and easy to understand (Chen *et al.*, 2003).

The first problem is related to model specification. The conventional OLS model that uses levels or changes in the exchange rates (the unhedged asset such as a spot rate being a dependent variable and the hedged asset such as a forward or futures rate being the independent variable) has been widely used in the literature (Ederington, 1979; Junkus and Lee, 1985; Malliaris and Urrutia, 1991; Benet, 1992). However, the problem arises in determining which of the specifications (price level or price change) is more appropriate than the other to estimate the hedge ratio. For example Witt *et al.* (1987) support the price-level model, whereas Hill and Schneeweis (1981) and Wilson (1983) support the price-change (return) model. Ghosh (1993, 1995, 1996) argues that these methods are misspecified, as using a price-level hedge ratio ignores short-term dynamics, whereas using a price-changes (return) hedge ratio ignores long-term relationships. Ghosh added an error-correction term to improve the model, as the first-difference model ignores the long-term relationship implied by the error-correction term. In addition, he argues that the omission of a cointegration relationship between variables (spot and forward rates) represented by the error-correction term produces a smaller hedge ratio than the optimal ratio. Lien (1996) was the first to prove this mathematically by showing that when estimating the hedge ratio using a first-difference model, agents will be under-hedged.

The use of the ECM of Engle and Granger (1987) for estimating the optimal hedge ratio for corn, soybeans, and wheat is found in Myers and Thompson (1989). Moreover, Chou *et al.* (1996) find that hedging under the ECM model outperforms the conventional model for Nikkei spot and futures indices. In the literature, OLS is criticised as being inappropriate to use in estimating the hedge ratio, due to the serial correlation and heteroskedasticity in the error term arising from the relationship between spot and forward rates (Hill and Schneeweis, 1981; Herbst *et al.*, 1993; Kenourgios *et al.*, 2008).

The second problem that arises in the literature relates to the dynamics of the hedge ratio. It is associated with the view of whether the hedge ratio is constant or changing over time, and the question of whether a conditional or unconditional probability distribution (moments) should be used to estimate it.[12] For example the static hedge ratio based on unconditional moments has been studied by Ederington, (1979), Howard and D'Antonio (1984), Benet (1992), Ghosh (1993, 1995, 1996), and Kolb and Okunev (1992, 1993). Alternatively, a dynamic (changing) hedge ratio based on conditional moments such as the ARCH and GARCH family of models—in which it is assumed that covariance and variance of returns are time-varying—has been studied in Cecchetti *et al.* (1988), Baillie and Myers (1991), Kroner and Sultan (1993), Sephton (1993), Brooks and Chong (2001), Hatemi-J and Roca (2006), Park and Jei (2010), and Hatemi-J and El-Khatib (2012). However, time-varying models also receive criticism, as they introduce too much noise that affects cost-effective hedges (Copeland and Zhu, 2006; Alexander and Barbosa, 2007).

In this chapter, we do not investigate this dynamic aspect of the hedge ratio; instead, the scope is limited to comparing different empirical-model specifications and estimation methods that minimise the variance of the hedge ratio, as in Moosa (2011a), who shows that financial-econometrics models used to estimate the hedge ratio fail to add value in improving the effectiveness of the hedge.[13] Therefore, he suggests that a naïve hedge ratio of 1 provides similar results to the sophisticated econometric models. The inferences that Moosa obtains suggest that the dominance of the naïve hedge ratio are consistent with those of Jong *et al.*

[12] From Chapter 3, given that the hedge ratio equals $h = \frac{Cov(R_U, R_A)}{Var(R_A)}$, time-variant or invariant is related to $Cov(R_U, R_A)$ and $Var(R_A)$.
[13] We do not compare a static hedge ratio with a dynamic hedge ratio; instead, we examine different techniques for estimating the hedge ratio that range from conventional models to sophisticated ones.

(1995), Jong *et al.* (1997), Grant and Eaker (1989), Maharaj *et al.* (2008), Alexander *et al.* (2013), and Wang *et al.* (2015).[14]

7.3 Data and Methodology

The data we use in this chapter can be found in Table 5.1. We assign x for the base currency, y for the exposure currency, and z for a third currency that is a cross-currency. For the money-market hedging, the correlation between $\Delta s(x/y)$ and $\Delta\bar{f}(x/y)$ determines the effectiveness of money-market hedging, whereas the correlation between the exposure-currency exchange rate $\Delta s(x/y)$ and the third-currency exchange rate $\Delta s(x/z)$ determines the effectiveness of cross-currency hedging. As in Chapter 3, the implicit forward rate is obtained using this equation.

$$\bar{F}_t = \frac{KS_t(1+i)/(1+i^*)}{K} = S_t\,(1+i)/(1+i^*) \tag{7.1}$$

According to the literature, in estimating the optimal hedge ratio we use nine different econometric models for comparison. After that, we measure the effectiveness of the hedge ratio by calculating VR as Equation (5.8), accompanied by VD as Equation (5.9), where we divide the rate of return under the unhedged position over the rate of return under the hedged position.

7.3.1 First-difference model using (OLS)

The conventional hedge ratio under OLS is estimated by Equation (3.19)

$$\Delta p_{u,t} = \alpha + h\Delta p_{a,t} + \varepsilon_t.$$

[14] Brooks *et al.* (2006) argue that a naïve hedge ratio of 1 becomes optimal only if we have perfect correlation between spot and futures, and that it is constant over time.

This OLS model is called 'conventional' as it uses historical data, and the R^2 obtained from the regression represents the effectiveness of the hedge. We use the OLS because of its simplicity, and because it is widely used among researchers. The OLS model can also be estimated using level data instead of first differences as

$$p_{u,t} = \alpha + hp_{a,t} + \varepsilon_t \tag{7.2}$$

7.3.2 First-difference model using Cochrance-Orcutt method with AR (1)

The Cochrance-Orcutt method overcomes the problem of serial correlation in the residuals—if it existed. This is because if we run a simple OLS estimation and there is serial correlation, our OLS will still provide the unbiased estimator but will not be the best linear unbiased efficient estimator (BLUE) (Brooks, 2014). In addition, the confidence interval and hypothesis testing become misleading, as they will depend on incorrect standard errors estimated from the OLS. This method consists of two iterative steps, which are (i) estimating first-order correlation τ; and (ii) estimating the generalised least squares (GLS) equation using $\hat{\tau}$ (Studenmund, 2011; Hill *et al.*, 2011). Suppose that there is an equation similar to Equation (3.19). First, we run a regression of lagged errors with AR(1)

$$\varepsilon_t = \tau\varepsilon_{t-1} + u_t \qquad -1 < \tau < 1 \tag{7.3}$$

Then, the estimated $\hat{\tau}$ from Equation (7.3) is multiplied by Equation (3.19) and used in a lagged version of the equation as

$$\hat{\tau}\Delta p_{u,t-1} = \hat{\tau}b_0 + \hat{\tau}h\Delta p_{a,t-1} + \hat{\tau}\varepsilon_{t-1} \tag{7.4}$$

Subtracting Equation (7.4) from Equation (3.19) we get

$$\Delta p_{u,t} - \hat{\tau}\Delta p_{u,t-1} = \alpha(1-\hat{\tau}) + h\big(\Delta p_{a,t} - \hat{\tau}\Delta p_{a,t-1}\big) + u_t \tag{7.5}$$

or it can be written in this form:

$$\Delta p^*_{u,t} = \alpha^* + h\Delta p^*_{a,t} + u^*_t \tag{7.6}$$

The use of an autoregressive model means that the dependent variable is related to its lag value. Coffey *et al.* (2000) use the Cochrance-Orcutt method in estimating the hedge ratio for some grains that are used to feed livestock.

7.3.3 Maximum-likelihood method with an MA (1)

A moving-average process combines both the average of the current period's random error and the previous period's random error (Gujarati, 2003). It is used whenever serial correlation exists. The error process is

$$\varepsilon_t = \theta u_{t-1} + u_t \tag{7.7}$$

This model suggests that error term follows a first-order moving average, and this process is short-lived with no memory of previous levels.

7.3.4 First-difference model using instrumental variables (IV) with an AR (1)

Instrumental variable (IV) is also used to estimate the hedge ratio. Given that the OLS is based on the assumption that the independent variable and the error term are uncorrelated, this means that the independent variable is exogenous. However, if the covariance between the independent variable and the error term is not equal to zero, the independent variable becomes endogenous. According to Wooldridge (2009), there are three causes for endogeneity (i) omitted variables; (ii) error in the variables; and (iii) measurement error in the independent variable. As a result, OLS becomes unreliable, because the coefficient is biased and inconsistent. To solve this problem, IV is proposed. For example if we have omitted a variable from the regression model, this omitted variable will definitely affect the error term, and if at the same time this omitted variable is correlated with $\Delta p_{a,t-1}$, OLS will be biased and inconsistent. Under IV, we add a new variable that is uncorrelated with the error term but is correlated with $\Delta p_{a,t-1}$. In this case the IV becomes consistent. The use of IV to estimate the hedge ratio of the returns of securities listed in the NYSE and the ASE was used by Scholes and Williams (1977).

7.3.5 First-difference model using a nonlinear quadratic specification

We also estimate the hedge ratio using a nonlinear regression first-difference model as

$$\Delta p_{u,t} = \alpha + h\Delta p_{a,t} + \gamma \Delta p_{a,t}^2 + \varepsilon_t \tag{7.8}$$

where we have a linear parameter γ and a squared term of the independent variable $p_{a,t}^2$. Such a model was proposed by Chow *et al.* (2000) in their study on the AUD, GBP, CAD, DEM, FRF, and JPY to capture the nonlinear relationship between spot and forward exchange rates.

7.3.6 First-difference model using a linear error-correction model (ECM)

Suppose that there is linear combination in the cointegration regression as in Equation (7.2)

$$p_{u,t} = \alpha + hp_{a,t} + \varepsilon_t$$

that is $p_{u,t}$ and $p_{a,t}$ to be cointegrated $\varepsilon_t \sim I(0)$ (Engle and Granger 1987). In other words, the residuals are stationary and the two series do not diverge too far from each other.[15] This suggests that Equation (7.4) is misspecified, because there is a long-run or equilibrium relationship between the two variables. Therefore, it would be better to respecify the model using an ECM to take into account short-term dynamics as in

$$\Delta p_{u,t} = \alpha + \sum_{i=1}^{n} \beta_i \Delta p_{u,t-i} + h\Delta p_{a,t} + \sum_{i=1}^{n} \gamma_i \Delta p_{a,t-i} + \theta \varepsilon_{t-1} + \zeta_t \tag{7.9}$$

where γ_i defines the short-term relationship between $\Delta p_{u,t}$ and $\Delta p_{a,t-i}$; ε_{t-1} is an error-correction term which is the lagged value of the empirical residual of a regression of $p_{u,t}$ on $p_{a,t}$ (which represents the long-term relationship or the cointegrating regression); θ, which is

[15] If there is a unit root and both series can be cointegrated.

the coefficient on the error-correction term, is a measure of the speed of adjustment to deviations from the long-run equilibrium condition. For a valid ECM, θ must be significantly negative. If ε_{t-1} is positive, this means that $p_{u,t-1}$ is above the equilibrium; it is too high, and it should fall in the next period so that the equilibrium error is corrected. Lien and Luo (1993) use an ECM as in Equation (7.9) in estimating the hedge ratio for a number of foreign currencies and stock-index futures. In addition, Alexander (1999) uses as ECM as in Equation (7.9) to estimate the optimal hedge ratio for equity-index tracking and hedging of international-equity portfolios. The ECM was also used by Hatemi-J and Roca (2010) in their study on the US and UK equity markets.

7.3.7 First-difference model using a nonlinear error-correction model (NECM)

We have NECM with A(L) and B(L) which represent lag polynomials.

$$\Delta p_{u,t} = A(L)\Delta p_{u,t-i} + B(L)\Delta p_{a,t} + \sum_{i=1}^{k} \gamma_i \varepsilon_{t-i}^{i} + \zeta_t \tag{7.10}$$

This model—proposed by Escribano (1978) to model economic variables that have statistical properties differing from classical linear time series properties—was used empirically by Hendry and Eriscon (1991) to analyse the demand for money in the United Kingdom over the period 1878 to 1970. Chow *et al.* (2000) also used such a model to capture the nonlinear relationship between the spot and forward rates for a number of currencies.

7.3.8 First-difference model using an autoregressive distributed lag ARDL (1,1)

Autoregressive distributed lag (ARDL) uses a lagged value of both the dependent variable and the independent variable. According to Hill *et al.* (2011), the ARDL has an advantage in that it eliminates serial correlation in the errors. The hedge ratio is estimated using the following model

$$\Delta p_{u,t} = \sum_{i=1}^{m} \alpha_i \Delta p_{u,t-i} + \sum_{i=0}^{n} \beta_i \, \Delta p_{a,t-i} + \zeta_t \qquad (7.11)$$

where the hedge ratio is represented by the long-run coefficient β_0. The number of lagged m and n of the model is based on selection criteria such as the Akaike Information Criterion (AIC) and Schwarz Criterion (SC).

7.3.9 First-difference model using an autoregressive distributed lag ARDL (1,1)

Again, the ARDL in Equation (7.11) is used here, but the hedge ratio is differently calculated using an impact coefficient as

$$h = \frac{\sum_{i=0}^{n} \beta_i}{1 - \sum_{i=1}^{m} \alpha_i} \qquad (7.12)$$

This hedge ratio can also be called a long-run hedge ratio.

7.4 Results and Analysis

Tables 7.1 to 7.10 present the results of estimating the hedge ratio using different econometric models for both money-market hedging and cross-currency hedging. They report goodness of fit, t statistic, VR, and VD.[16] Money-market hedging results (in Tables 7.1 to 7.5) show that a perfect hedge is obtained for all of the econometric models, as VD is almost equal to 99 percent. The results also show that a hedge ratio of 1 (naïve model) is obtained.[17]

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[16] According to Malliaris and Urrutia (1991), the R^2 obtained from the first-difference model can be used for the effectiveness of the hedge, because the R^2 will be equal to the hedge ratio; whereas, Lindahl (1991) shows that the Mean Absolute Difference (MAD) can be used for the effectiveness of the hedge for risk-minimising the portfolio. Moreover, Graff *et al.* (1997) show that the Root Mean Square Percentage Error (RMSPE) can be used for the effectiveness of the hedge. In this chapter, we use R^2, VR, and VD for the effectiveness of the hedge. See Chapter 3 for more details on the effectiveness of the hedge.

[17] The naïve model assumes that the hedge ratio is always a negative one. This means taking an amount equal in value to the spot position, but in the opposite position to the financial derivative or asset (long AUD 1 and short AUD 1, or vice versa).

Table 7.1 Money-Market Hedging—KWD

	x	y	R^2	*h*	*t statistic*	VR	VD (%)
OLS							
	KWD	CHF	0.997	1.019*	211.042	71.510*	98.602
	KWD	GBP	0.987	1.056*	103.125	38.608*	97.410
	KWD	JPY	0.987	1.046*	104.663	53.037*	98.115
Cochrance-Orcutt							
	KWD	CHF	0.986	1.005*	101.993	72.468*	98.620
	KWD	GBP	0.977	0.998*	76.500	43.020*	97.676
	KWD	JPY	0.984	1.000*	95.148	60.121*	98.337
MLE							
	KWD	CHF	0.986	1.004*	101.966	72.466*	98.620
	KWD	GBP	0.977	0.998*	76.995	43.026*	97.675
	KWD	JPY	0.984	0.999*	96.521	60.121*	98.336
IV							
	KWD	CHF	0.978	0.910*	14.144	44.038*	97.729
	KWD	GBP	0.949	1.173*	1.173	19.638*	94.908
	KWD	JPY	0.983	1.013*	19.840	59.464*	98.318
Quadratic							
	KWD	CHF	0.986	1.008*	93.720	72.457*	98.620
	KWD	GBP	0.977	1.002*	75.539	43.073*	97.678
	KWD	JPY	0.983	0.999*	90.864	60.122*	98.337
Linear ECM							
	KWD	CHF	0.987	1.008*	102.119	72.465*	98.620
	KWD	GBP	0.979	0.998*	77.860	43.013*	97.675
	KWD	JPY	0.985	1.006*	92.903	59.938*	98.332
Nonlinear ECM							
	KWD	CHF	0.988	1.007*	102.656	72.470*	98.620
	KWD	GBP	0.979	0.996*	77.835	42.973*	97.673
	KWD	JPY	0.985	1.001*	91.025	60.116*	98.337
ARDL							
	KWD	CHF	0.986	1.007*	98.757	72.469*	98.620
	KWD	GBP	0.978	1.001*	76.930	43.067*	97.678
	KWD	JPY	0.984	1.004*	90.540	60.036*	98.334
ARDL (long-run)							
	KWD	CHF	0.986	1.024*	43.385	70.945*	98.590
	KWD	GBP	0.978	1.045*	41.678	40.226*	97.514
	KWD	JPY	0.984	1.034*	42.650	56.134*	98.219

* Significant at the 5% level

Cross-currency hedging results (in Tables 7.6 to 7.10) show that different econometric models under cross-currency hedging produce a hedge ratio that is almost the same in each model, but neither close to unity nor significant in several currency combinations. Comparing the hedge ratio with money-market hedging, we notice that currency combinations under cross-currency hedging do not reduce the variance significantly (no perfect hedge). This is attributed either to no relationship or a weak relationship between the exposure-currency exchange rate $\Delta s(x/y)$ and the third-currency exchange rate $\Delta s(x/z)$.

On the other hand, the perfect hedge for all currency combinations achieved under money-market hedging is attributed to the strong relationship between the spot rate and the implicit forward rate. The results suggest that money-market hedging is preferred to cross-currency hedging. In addition, they suggest that the sophistication of the econometric models used to estimate the hedge ratio does not yield any difference compared with the simple OLS model. The results are approximately the same. The rest of the Tables and Figures are included at the end of this chapter.

7.5 Conclusion

In this chapter, we examined the effectiveness of different econometric models in minimising the variance of the hedge ratio for the GCC currencies under money-market hedging and cross-currency hedging. The aim of this examination was to determine whether different model specifications and estimation methods yield different effectiveness results. In other words, does the sophistication of the model improve the effectiveness of the hedge? Our results showed that these econometric models fail either to add value or to improve the effectiveness of the hedge. This implies that there is no need for a sophisticated econometric model to estimate the hedge ratio, because what matters is correlation.

Table 7.2 Money-Market Hedging—SAR

	x	y	R^2	*h*	*t statistic*	VR	VD (%)
OLS							
	SAR	CHF	0.998	1.016*	256.430	145.068	99.311
	SAR	GBP	0.994	1.028*	151.293	101.231	99.012
	SAR	JPY	0.991	1.054*	127.611	99.477	98.995
Cochrance-Orcutt							
	SAR	CHF	0.994	0.994*	148.104	154.284*	99.352
	SAR	GBP	0.991	1.007*	119.764	105.141*	99.049
	SAR	JPY	0.993	1.012*	141.149	123.604*	99.191
MLE							
	SAR	CHF	0.993	0.993*	147.756	154.296*	99.351
	SAR	GBP	0.990	1.007*	120.821	105.144*	99.048
	SAR	JPY	0.992	1.011*	135.675	123.654*	99.191
IV							
	SAR	CHF	0.992	0.951*	27.876	119.543*	99.163
	SAR	GBP	0.991	1.014*	36.071	104.832*	99.046
	SAR	JPY	0.991	1.043*	27.768	108.983*	99.082
Quadratic							
	SAR	CHF	0.994	0.993*	145.976	154.271*	99.352
	SAR	GBP	0.991	1.005*	120.704	105.034*	99.048
	SAR	JPY	0.992	1.010*	130.819	123.684*	99.191
Linear ECM							
	SAR	CHF	0.994	0.998*	146.804	154.131*	99.351
	SAR	GBP	0.991	1.008*	121.452	105.160*	99.049
	SAR	JPY	0.993	1.016*	133.916	123.121*	99.188
Nonlinear ECM							
	SAR	CHF	0.994	0.998*	145.897	154.080*	99.351
	SAR	GBP	0.991	1.008*	120.997	105.160*	99.049
	SAR	JPY	0.993	1.016*	132.871	123.119*	99.188
ARDL							
	SAR	CHF	0.994	0.997*	148.744	154.240*	99.352
	SAR	GBP	0.991	1.009*	118.434	105.162*	99.049
	SAR	JPY	0.993	1.014*	138.986	123.354*	99.189
ARDL (long-run)							
	SAR	CHF	0.994	1.017*	61.623	143.097*	99.301
	SAR	GBP	0.991	1.022*	70.324	103.431*	99.033
	SAR	JPY	0.993	1.044*	39.187	108.018*	99.074

* Significant at the 5% level

Table 7.3 Money-Market Hedging—AED

	x	y	R^2	*h*	*t statistic*	VR	VD (%)
OLS							
	AED	CHF	0.998	0.992*	248.258	201.256*	99.503
	AED	GBP	0.988	1.031*	108.371	100.768*	99.008
	AED	JPY	0.993	1.018*	143.840	158.724*	99.370
Cochrance-Orcutt							
	AED	CHF	0.996	0.992*	209.815	200.688*	99.502
	AED	GBP	0.992	1.004*	131.464	100.440*	99.004
	AED	JPY	0.995	1.008*	185.717	166.189*	99.398
MLE							
	AED	CHF	0.995	0.993*	186.950	201.789*	99.504
	AED	GBP	0.991	1.006*	129.906	100.948*	99.009
	AED	JPY	0.994	1.005*	171.785	166.747*	99.400
IV							
	AED	CHF	0.990	0.929*	24.059	101.290*	99.013
	AED	GBP	0.987	1.075*	29.488	78.314*	98.723
	AED	JPY	0.993	0.964*	30.584	136.585*	99.268
Quadratic							
	AED	CHF	0.995	1.000*	163.120	203.205*	99.507
	AED	GBP	0.991	1.014*	121.989	102.386*	99.023
	AED	JPY	0.994	1.000*	149.347	167.504*	99.403
Linear ECM							
	AED	CHF	0.996	0.999*	190.693	203.168*	99.508
	AED	GBP	0.992	1.011*	128.618	101.974*	99.019
	AED	JPY	0.996	1.010*	167.955	165.222*	99.395
Nonlinear ECM							
	AED	CHF	0.997	0.998*	189.857	203.084*	99.508
	AED	GBP	0.992	1.011*	127.600	101.982*	99.019
	AED	JPY	0.996	1.010*	166.626	165.264*	99.395
ARDL							
	AED	CHF	0.996	0.999*	190.026	203.194*	99.508
	AED	GBP	0.992	1.012*	126.035	102.020*	99.020
	AED	JPY	0.996	1.009*	46.338	165.456*	99.396
ARDL (long-run)							
	AED	CHF	0.996	1.036*	46.553	160.827*	99.378
	AED	GBP	0.992	1.049*	50.571	93.948*	98.936
	AED	JPY	0.996	1.036*	43.459	138.533*	99.278

* Significant at the 5% level

Table 7.4 Money-Market Hedging—QAR

	x	y	R^2	*h*	*t statistic*	VR	VD (%)
OLS							
	QAR	CHF	0.995	1.038*	135.890	40.069	97.504
	QAR	GBP	0.986	1.092*	79.500	28.747	96.521
	QAR	JPY	0.997	1.049*	168.700	19.140	94.775
Cochrance-Orcutt							
	QAR	CHF	0.978	0.999*	54.745	44.624*	97.759
	QAR	GBP	0.971	1.019*	53.404	33.921*	97.052
	QAR	JPY	0.955	0.979*	42.393	21.666*	95.384
MLE							
	QAR	CHF	0.978	1.004*	56.895	44.296*	97.742
	QAR	GBP	0.970	1.020*	53.945	33.916*	97.051
	QAR	JPY	0.955	0.987*	44.469	21.573*	95.364
IV							
	QAR	CHF	0.973	0.918*	12.845	37.203*	97.312
	QAR	GBP	0.969	0.984*	19.855	32.784*	96.950
	QAR	JPY	0.951	0.993*	10.101	21.477*	95.344
Quadratic							
	QAR	CHF	0.978	0.990*	61.231	44.951*	97.775
	QAR	GBP	0.971	1.011*	52.187	33.873*	97.048
	QAR	JPY	0.955	0.974*	42.690	21.690*	95.390
Linear ECM							
	QAR	CHF	0.980	0.999*	56.631	44.628*	97.759
	QAR	GBP	0.974	1.009*	53.868	33.846*	97.045
	QAR	JPY	0.961	0.984*	45.026	21.612*	95.373
Nonlinear ECM							
	QAR	CHF	0.981	1.005*	56.247	44.281*	97.742
	QAR	GBP	0.975	1.001*	53.455	33.637*	97.027
	QAR	JPY	0.967	0.987*	48.187	21.578*	95.366
ARDL							
	QAR	CHF	0.981	1.002*	57.432	44.487*	97.752
	QAR	GBP	0.972	1.019*	50.944	33.923*	97.052
	QAR	JPY	0.963	0.977*	46.338	21.675*	95.386
ARDL (long-run)							
	QAR	CHF	0.981	1.047*	50.116	38.562*	97.407
	QAR	GBP	0.972	1.057*	43.999	32.346*	96.908
	QAR	JPY	0.963	1.041*	43.459	19.616*	94.902

* Significant at the 5% level

Table 7.5 Money-Market Hedging—BHD

	x	y	R^2	*h*	*t statistic*	VR	VD (%)
OLS							
	BHD	CHF	0.998	1.025*	180.410	289.865*	99.655
	BHD	GBP	0.996	1.061*	120.257	79.451*	98.741
	BHD	JPY	0.999	1.002*	222.024	192.74*	98.998
Cochrance-Orcutt							
	BHD	CHF	0.996	1.016*	149.111	293.144*	99.659
	BHD	GBP	0.990	0.999*	70.538	90.174*	98.891
	BHD	JPY	0.992	1.010*	80.126	125.086*	99.201
MLE							
	BHD	CHF	0.996	1.016*	146.640	293.388*	99.659
	BHD	GBP	0.989	1.003*	70.045	90.987*	98.900
	BHD	JPY	0.992	1.010*	80.300	125.091*	99.200
IV							
	BHD	CHF	0.995	0.977*	26.657	197.000*	99.492
	BHD	GBP	0.988	1.049*	31.861	85.360*	98.828
	BHD	JPY	0.991	0.984*	36.293	115.877*	99.137
Quadratic							
	BHD	CHF	0.997	1.019*	127.759	293.791*	99.660
	BHD	GBP	0.990	1.011*	68.572	92.390*	98.918
	BHD	JPY	0.992	1.000*	74.441	123.784*	99.192
Linear ECM							
	BHD	CHF	0.997	1.017*	137.840	293.581*	99.659
	BHD	GBP	0.992	1.000*	74.810	90.257*	98.892
	BHD	JPY	0.993	1.012*	83.084	124.967*	99.200
Nonlinear ECM							
	BHD	CHF	0.998	1.020*	133.879	293.710*	99.660
	BHD	GBP	0.993	0.992*	74.230	87.415*	98.856
	BHD	JPY	0.995	1.021*	94.216	123.070*	99.187
ARDL							
	BHD	CHF	0.997	1.021*	135.127	293.416*	99.659
	BHD	GBP	0.991	1.007*	74.242	91.708*	98.910
	BHD	JPY	0.992	1.011*	81.984	125.051*	99.200
ARDL (long-run)							
	BHD	CHF	0.997	1.060*	48.080	197.765*	99.494
	BHD	GBP	0.991	1.055*	43.083	82.732*	98.791
	BHD	JPY	0.992	1.043*	51.981	110.330*	99.094

* Significant at the 5% level

Table 7.6 Cross-Currency Hedging—KWD

	x	y	z	R^2	*h*	*t statistic*	VR	VD (%)
1) OLS								
	KWD	CHF	JPY	0.068	0.291*	3.185	1.072	6.756
	KWD	CHF	GBP	0.099	0.356*	3.931	1.110	9.941
	KWD	GBP	JPY	0.001	-0.020	0.001	1.000	0.000
	KWD	GBP	CHF	0.163	0.324*	3.931	1.190	15.972
	KWD	JPY	CHF	0.068	0.232*	3.185	1.072	6.756
	KWD	JPY	GBP	0.000	0.000	0.001	1.000	0.000
2) Cochrance-Orcutt								
	KWD	CHF	JPY	0.078	0.311*	3.372	1.072	6.725
	KWD	CHF	GBP	0.175	0.512*	5.357	1.194	16.277
	KWD	GBP	JPY	0.005	-0.021	-0.270	1.001	0.051
	KWD	GBP	CHF	0.160	0.321*	5.128	1.194	16.282
	KWD	JPY	CHF	0.078	0.248*	3.383	1.072	6.726
	KWD	JPY	GBP	0.005	-0.038	-0.405	1.000	0.038
3) MLE								
	KWD	CHF	JPY	0.083	0.316*	3.476	1.072	6.708
	KWD	CHF	GBP	0.179	0.514*	5.431	1.194	16.275
	KWD	GBP	JPY	0.004	-0.016	-0.213	1.000	0.049
	KWD	GBP	CHF	0.163	0.324*	5.205	1.194	16.283
	KWD	JPY	CHF	0.078	0.247*	3.371	1.072	6.729
	KWD	JPY	GBP	0.004	-0.031	-0.333	1.000	0.048
4) IV								
	KWD	CHF	JPY	0.063	0.480*	1.313	1.041	3.912
	KWD	CHF	GBP	0.151	0.515*	1.404	1.194	16.274
	KWD	GBP	JPY	0.000	-0.029	-0.137	1.000	0.042
	KWD	GBP	CHF	0.139	0.254*	1.384	1.184	15.536
	KWD	JPY	CHF	0.078	0.206*	0.678	1.071	6.671
	KWD	JPY	GBP	0.001	-0.023	-0.333	1.001	0.051
5) Quadratic								
	KWD	CHF	JPY	0.075	0.283*	3.082	1.072	6.751
	KWD	CHF	GBP	0.177	0.533*	5.443	1.194	16.224
	KWD	GBP	JPY	0.024	-0.008	-0.109	1.000	0.033
	KWD	GBP	CHF	0.234	0.401*	6.328	1.181	15.359
	KWD	JPY	CHF	0.117	0.160*	2.119	1.065	6.111
	KWD	JPY	GBP	0.033	0.016	0.172	0.999	-0.088
6) Linear ECM								
	KWD	CHF	JPY	0.100	0.325*	3.509	1.071	6.664
	KWD	CHF	GBP	0.179	0.521*	5.295	1.194	16.263
	KWD	GBP	JPY	0.021	-0.029	-0.373	1.000	0.042
	KWD	GBP	CHF	0.196	0.326*	5.234	1.194	16.282
	KWD	JPY	CHF	0.107	0.249*	3.415	1.072	6.721
	KWD	JPY	GBP	0.019	-0.028	-0.290	1.001	0.051
7) Nonlinear ECM								
	KWD	CHF	JPY	0.121	0.315*	3.409	1.072	6.710
	KWD	CHF	GBP	0.185	0.515*	5.211	1.194	16.273
	KWD	GBP	JPY	0.028	-0.031	-0.404	1.000	0.036
	KWD	GBP	CHF	0.223	0.318*	5.140	1.194	16.277
	KWD	JPY	CHF	0.122	0.243*	3.330	1.072	6.742
	KWD	JPY	GBP	0.019	-0.028	-0.293	1.001	0.050
8) ARDL(1,1)								
	KWD	CHF	JPY	0.089	0.301*	3.112	1.072	6.748
	KWD	CHF	GBP	0.201	0.535*	5.512	1.194	16.218
	KWD	GBP	JPY	0.007	-0.014	-0.172	1.000	0.046
	KWD	GBP	CHF	0.206	0.343*	5.512	1.194	16.222
	KWD	JPY	CHF	0.146	0.222*	3.112	1.072	6.744
	KWD	JPY	GBP	0.057	-0.016	-0.172	1.000	0.044
9) ARDL(1,1) long-run								
	KWD	CHF	JPY	0.089	0.462*	3.415	1.047	4.448
	KWD	CHF	GBP	0.201	0.264*	1.886	1.144	12.614
	KWD	GBP	JPY	0.007	-0.009	-0.059	1.000	0.036
	KWD	GBP	CHF	0.206	0.584*	4.326	1.061	5.713
	KWD	JPY	CHF	0.146	0.159*	1.121	1.065	6.088
	KWD	JPY	GBP	0.057	-0.336	-2.133	1.078	7.204

* Significant at the 5% level

Table 7.7 Cross-Currency Hedging—SAR

	x	y	z	R^2	*h*	*t statistic*	VR	VD (%)
1) OLS								
	SAR	CHF	JPY	0.118	0.435*	4.320	1.133	11.761
	SAR	CHF	GBP	0.280	0.675*	7.386	1.390	28.041
	SAR	GBP	JPY	0.007	0.082	0.987	1.007	0.691
	SAR	GBP	CHF	0.280	0.415*	7.386	1.380	28.041
	SAR	JPY	CHF	0.118	0.270*	4.320	1.133	11.761
	SAR	JPY	GBP	0.007	0.083	0.987	1.007	0.691
2) Cochrance-Orcutt								
	SAR	CHF	JPY	0.137	0.464*	4.611	1.133	11.710
	SAR	CHF	GBP	0.294	0.673*	7.444	1.390	28.040
	SAR	GBP	JPY	0.017	0.077	0.921	1.007	0.687
	SAR	GBP	CHF	0.280	0.407*	7.215	1.389	28.030
	SAR	JPY	CHF	0.122	0.281*	4.469	1.133	11.741
	SAR	JPY	GBP	0.006	0.075	0.885	1.007	0.684
3) MLE								
	SAR	CHF	JPY	0.142	0.466*	4.733	1.133	11.701
	SAR	CHF	GBP	0.297	0.668*	7.530	1.390	28.038
	SAR	GBP	JPY	0.017	0.083	0.995	1.007	0.691
	SAR	GBP	CHF	0.281	0.410*	7.287	1.390	28.037
	SAR	JPY	CHF	0.123	0.283*	4.485	1.133	11.736
	SAR	JPY	GBP	0.007	0.083	0.979	1.007	0.691
4) IV								
	SAR	CHF	JPY	0.095	0.652*	1.499	1.097	8.856
	SAR	CHF	GBP	0.285	0.668*	2.438	1.390	28.037
	SAR	GBP	JPY	0.005	0.072	0.341	1.007	0.678
	SAR	GBP	CHF	0.287	0.425*	2.327	1.389	28.025
	SAR	JPY	CHF	0.045	0.477*	0.942	1.051	4.848
	SAR	JPY	GBP	0.001	0.138	0.594	1.004	0.400
5) Quadratic								
	SAR	CHF	JPY	0.130	0.443*	4.402	1.133	11.757
	SAR	CHF	GBP	0.313	0.728*	7.910	1.386	27.870
	SAR	GBP	JPY	0.017	0.077	0.923	1.007	0.688
	SAR	GBP	CHF	0.312	0.439*	7.848	1.388	27.949
	SAR	JPY	CHF	0.162	0.242*	3.902	1.132	11.633
	SAR	JPY	GBP	0.052	0.133	1.558	1.005	0.451
6) Linear ECM								
	SAR	CHF	JPY	0.157	0.487*	4.752	1.131	11.595
	SAR	CHF	GBP	0.321	0.725*	7.838	1.387	27.892
	SAR	GBP	JPY	0.037	0.082	0.977	1.007	0.691
	SAR	GBP	CHF	0.344	0.428*	7.824	1.389	28.013
	SAR	JPY	CHF	0.164	0.285*	4.606	1.133	11.724
	SAR	JPY	GBP	0.007	0.080	0.922	1.007	0.689
7) Nonlinear ECM								
	SAR	CHF	JPY	0.165	0.489*	4.742	1.131	11.584
	SAR	CHF	GBP	0.331	0.720*	7.777	1.387	27.920
	SAR	GBP	JPY	0.042	0.092	1.081	1.007	0.682
	SAR	GBP	CHF	0.388	0.445*	8.288	1.387	27.896
	SAR	JPY	CHF	0.176	0.288*	4.651	1.133	11.709
	SAR	JPY	GBP	0.013	0.078	0.897	1.007	0.688
8) ARDL(1,1)								
	SAR	CHF	JPY	0.144	0.449*	4.302	1.133	11.749
	SAR	CHF	GBP	0.308	0.738*	7.812	1.385	27.798
	SAR	GBP	JPY	0.025	0.086	0.999	1.007	0.690
	SAR	GBP	CHF	0.353	0.422*	7.812	1.390	28.034
	SAR	JPY	CHF	0.159	0.269*	4.302	1.133	11.760
	SAR	JPY	GBP	0.028	0.085	0.999	1.007	0.690
9) ARDL(1,1) long-run								
	SAR	CHF	JPY	0.144	0.608*	4.392	1.110	9.901
	SAR	CHF	GBP	0.308	0.444*	3.332	1.329	24.761
	SAR	GBP	JPY	0.025	0.081	0.460	1.007	0.690
	SAR	GBP	CHF	0.353	0.669*	5.057	1.213	17.587
	SAR	JPY	CHF	0.159	0.320*	2.734	1.128	11.361
	SAR	JPY	GBP	0.028	-0.070	-0.466	1.016	1.607

* Significant at the 5% level

Table 7.8 Cross-Currency Hedging—AED

	x	y	z	R^2	*h*	*t statistic*	VR	VD (%)
1) OLS								
	AED	CHF	JPY	0.120	0.440*	4.310	1.137	12.021
	AED	CHF	GBP	0.287	0.690*	7.394	1.402	28.677
	AED	GBP	JPY	0.006	0.076	0.912	1.006	0.608
	AED	GBP	CHF	0.287	0.415*	7.394	1.402	28.677
	AED	JPY	CHF	0.120	0.273*	4.311	1.137	12.021
	AED	JPY	GBP	0.006	0.079	0.912	1.006	0.608
2) Cochrance-Orcutt								
	AED	CHF	JPY	0.143	0.469*	4.656	1.136	11.970
	AED	CHF	GBP	0.303	0.684*	7.511	1.402	28.674
	AED	GBP	JPY	0.019	0.076	0.911	1.006	0.608
	AED	GBP	CHF	0.287	0.409*	7.231	1.402	28.670
	AED	JPY	CHF	0.126	0.288*	4.477	1.136	11.987
	AED	JPY	GBP	0.006	0.078	0.897	1.006	0.607
3) MLE								
	AED	CHF	JPY	0.145	0.472*	4.741	1.136	11.959
	AED	CHF	GBP	0.304	0.682*	7.564	1.402	28.673
	AED	GBP	JPY	0.018	0.075	0.902	1.006	0.607
	AED	GBP	CHF	0.288	0.410*	7.295	1.402	28.672
	AED	JPY	CHF	0.125	0.285*	4.457	1.136	11.999
	AED	JPY	GBP	0.006	0.079	0.908	1.006	0.608
4) IV								
	AED	CHF	JPY	0.150	0.516*	1.286	1.132	11.664
	AED	CHF	GBP	0.267	0.765*	2.812	1.396	28.348
	AED	GBP	JPY	0.001	0.024	0.130	1.003	0.323
	AED	GBP	CHF	0.279	0.410*	1.994	1.402	28.673
	AED	JPY	CHF	0.137	0.398*	1.135	1.105	9.513
	AED	JPY	GBP	0.004	0.169	0.685	1.001	[0.169]
5) Quadratic								
	AED	CHF	JPY	0.130	0.448*	4.390	1.137	12.017
	AED	CHF	GBP	0.318	0.739*	7.881	1.399	28.537
	AED	GBP	JPY	0.024	0.069	0.818	1.006	0.601
	AED	GBP	CHF	0.322	0.440*	7.888	1.400	28.577
	AED	JPY	CHF	0.163	0.245*	3.902	1.135	11.898
	AED	JPY	GBP	0.052	0.125	1.441	1.004	0.401
6) Linear ECM								
	AED	CHF	JPY	0.168	0.502*	4.872	1.134	11.782
	AED	CHF	GBP	0.325	0.735*	7.823	1.400	28.557
	AED	GBP	JPY	0.041	0.082	0.982	1.006	0.604
	AED	GBP	CHF	0.348	0.430*	7.815	1.401	28.639
	AED	JPY	CHF	0.178	0.295*	4.689	1.136	11.946
	AED	JPY	GBP	0.006	0.082	0.918	1.006	0.607
7) Nonlinear ECM								
	AED	CHF	JPY	0.174	0.500*	4.799	1.134	11.796
	AED	CHF	GBP	0.335	0.730*	7.752	1.400	28.583
	AED	GBP	JPY	0.044	0.090	1.055	1.006	0.590
	AED	GBP	CHF	0.392	0.447*	8.276	1.399	28.513
	AED	JPY	CHF	0.196	0.295*	4.716	1.136	11.941
	AED	JPY	GBP	0.014	0.080	0.887	1.006	0.608
8) ARDL(1,1)								
	AED	CHF	JPY	0.142	0.449*	4.280	1.137	12.016
	AED	CHF	GBP	0.313	0.749*	7.832	1.398	28.475
	AED	GBP	JPY	0.026	0.087	1.001	1.006	0.598
	AED	GBP	CHF	0.357	0.426*	7.832	1.402	28.658
	AED	JPY	CHF	0.157	0.273*	4.280	1.137	12.021
	AED	JPY	GBP	0.031	0.088	1.001	1.006	0.601
9) ARDL(1,1) long-run								
	AED	CHF	JPY	0.142	0.611*	4.362	1.114	10.204
	AED	CHF	GBP	0.313	0.463*	3.402	1.343	25.555
	AED	GBP	JPY	0.026	0.097	0.547	1.006	0.564
	AED	GBP	CHF	0.357	0.660*	5.015	1.230	18.725
	AED	JPY	CHF	0.157	0.336*	2.876	1.129	11.389
	AED	JPY	GBP	0.031	-0.079	-0.517	1.018	1.779

* Significant at the 5% level, [ ] inverted

Table 7.9 Cross-Currency Hedging—QAR

	x	y	z	R^2	*h*	*t statistic*	VR	VD (%)
1) OLS								
	QAR	CHF	JPY	0.129	0.495*	3.568	1.148	12.895
	QAR	CHF	GBP	0.232	0.622*	5.102	1.303	23.241
	QAR	GBP	JPY	0.001	0.035	0.301	1.001	0.105
	QAR	GBP	CHF	0.232	0.373*	5.102	1.303	23.241
	QAR	JPY	CHF	0.119	0.071*	3.412	1.135	11.925
	QAR	JPY	GBP	0.001	0.030	0.301	1.001	0.105
2) Cochrance-Orcutt								
	QAR	CHF	JPY	0.163	0.521*	3.813	1.148	12.860
	QAR	CHF	GBP	0.264	0.611*	5.288	1.303	23.233
	QAR	GBP	JPY	0.033	0.079	0.698	1.000	[0.059]
	QAR	GBP	CHF	0.243	0.353*	4.913	1.302	23.174
	QAR	JPY	CHF	0.135	0.271*	3.652	1.148	12.876
	QAR	JPY	GBP	0.001	0.029	0.285	1.001	0.105
3) MLE								
	QAR	CHF	JPY	0.164	0.515*	3.832	1.148	12.874
	QAR	CHF	GBP	0.264	0.601*	5.315	1.302	23.214
	QAR	GBP	JPY	0.026	0.066	0.584	1.000	0.021
	QAR	GBP	CHF	0.239	0.358*	4.960	1.302	23.203
	QAR	JPY	CHF	0.134	0.270*	3.648	1.148	12.880
	QAR	JPY	GBP	0.001	0.027	0.268	1.001	0.104
4) IV								
	QAR	CHF	JPY	0.123	0.439*	0.809	1.146	12.734
	QAR	CHF	GBP	0.205	0.700*	2.417	1.297	22.876
	QAR	GBP	JPY	0.001	0.027	0.148	1.001	0.101
	QAR	GBP	CHF	0.230	0.362*	1.463	1.302	23.218
	QAR	JPY	CHF	0.111	0.284*	1.002	1.147	12.788
	QAR	JPY	GBP	0.001	0.024	0.148	1.001	0.100
5) Quadratic								
	QAR	CHF	JPY	0.142	0.496*	3.579	1.148	12.895
	QAR	CHF	GBP	0.252	0.682*	5.355	1.299	23.030
	QAR	GBP	JPY	0.047	0.034	0.298	1.001	0.105
	QAR	GBP	CHF	0.294	0.392*	5.521	1.302	23.186
	QAR	JPY	CHF	0.190	0.244*	3.425	1.147	12.841
	QAR	JPY	GBP	0.053	0.100	0.957	1.004	[0.436]
6) Linear ECM								
	QAR	CHF	JPY	0.221	0.554*	4.070	1.146	12.714
	QAR	CHF	GBP	0.289	0.669*	5.338	1.301	23.109
	QAR	GBP	JPY	0.093	0.046	0.402	1.001	0.095
	QAR	GBP	CHF	0.317	0.386*	5.360	1.302	23.213
	QAR	JPY	CHF	0.180	0.297*	3.996	1.145	12.638
	QAR	JPY	GBP	0.019	0.046	0.432	1.001	0.078
7) Nonlinear ECM								
	QAR	CHF	JPY	0.285	0.565*	4.272	1.145	12.638
	QAR	CHF	GBP	0.335	0.641*	5.192	1.302	23.219
	QAR	GBP	JPY	0.107	0.049	0.431	1.001	0.087
	QAR	GBP	CHF	0.328	0.390*	5.359	1.302	23.194
	QAR	JPY	CHF	0.211	0.326*	4.306	1.137	12.075
	QAR	JPY	GBP	0.024	0.056	0.517	1.000	0.028
8) ARDL(1,1)								
	QAR	CHF	JPY	0.174	0.515*	3.616	1.148	12.874
	QAR	CHF	GBP	0.285	0.698*	5.574	1.297	22.900
	QAR	GBP	JPY	0.060	0.078	0.671	1.000	[0.061]
	QAR	GBP	CHF	0.321	0.397*	5.574	1.301	23.145
	QAR	JPY	CHF	0.173	0.270*	3.616	1.148	12.879
	QAR	JPY	GBP	0.029	0.071	0.671	1.000	[0.078]
9) ARDL(1,1) long-run								
	QAR	CHF	JPY	0.174	0.608*	3.314	1.139	12.217
	QAR	CHF	GBP	0.285	0.374*	2.426	1.243	19.553
	QAR	GBP	JPY	0.060	-0.109	-0.404	1.017	1.670
	QAR	GBP	CHF	0.321	0.727*	3.568	1.024	2.380
	QAR	JPY	CHF	0.173	0.302*	1.951	1.144	12.569
	QAR	JPY	GBP	0.029	-0.195	-1.145	1.057	5.369

* Significant at the 5% level, [ ] inverted

Table 7.10 Cross-Currency Hedging—BHD

	x	y	z	R^2	*h*	*t statistic*	VR	VD (%)
1) OLS								
	BHD	CHF	JPY	0.053	0.436*	1.777	1.110	5.252
	BHD	CHF	GBP	0.160	0.530*	3.291	1.190	15.970
	BHD	GBP	JPY	0.039	-0.120	-1.515	1.010	3.874
	BHD	GBP	CHF	0.160	0.300*	3.291	1.190	15.970
	BHD	JPY	CHF	0.053	0.135*	1.777	1.055	5.252
	BHD	JPY	GBP	0.039	-0.154	-1.515	1.040	3.874
2) Cochrance-Orcutt								
	BHD	CHF	JPY	0.084	0.362*	1.716	1.055	5.229
	BHD	CHF	GBP	0.216	0.527*	3.587	1.190	15.968
	BHD	GBP	JPY	0.073	-0.215	-1.262	1.039	3.799
	BHD	GBP	CHF	0.182	0.270*	3.052	1.188	15.801
	BHD	JPY	CHF	0.072	0.116*	1.598	1.054	5.147
	BHD	JPY	GBP	0.058	-0.136	-1.314	1.040	3.820
3) MLE								
	BHD	CHF	JPY	0.093	0.378*	1.854	1.055	5.249
	BHD	CHF	GBP	0.221	0.517*	3.724	1.190	15.958
	BHD	GBP	JPY	0.067	-0.225	-1.353	1.040	3.834
	BHD	GBP	CHF	0.174	0.276*	3.096	1.188	15.859
	BHD	JPY	CHF	0.074	0.128*	1.730	1.055	5.235
	BHD	JPY	GBP	0.056	-0.143	-1.372	1.040	3.853
4) IV								
	BHD	CHF	JPY	0.048	0.399*	0.939	1.055	5.247
	BHD	CHF	GBP	0.150	0.687*	2.026	1.171	14.591
	BHD	GBP	JPY	0.035	-0.290	-0.705	1.039	3.776
	BHD	GBP	CHF	0.158	0.348*	1.555	1.184	15.572
	BHD	JPY	CHF	0.044	0.177*	1.004	1.050	4.751
	BHD	JPY	GBP	0.048	-0.168	-0.989	1.040	3.846
5) Quadratic								
	BHD	CHF	JPY	0.071	0.245*	0.955	1.048	4.542
	BHD	CHF	GBP	0.171	0.588*	3.370	1.187	15.782
	BHD	GBP	JPY	0.117	-0.029	-0.155	1.009	0.852
	BHD	GBP	CHF	0.231	0.316*	3.570	1.189	15.930
	BHD	JPY	CHF	0.104	0.126*	1.672	1.055	5.223
	BHD	JPY	GBP	0.092	-0.080	-0.743	1.031	2.979
6) Linear ECM								
	BHD	CHF	JPY	0.170	0.473*	2.160	1.045	4.289
	BHD	CHF	GBP	0.256	0.590*	3.600	1.187	15.771
	BHD	GBP	JPY	0.127	-0.234	-1.384	1.040	3.858
	BHD	GBP	CHF	0.286	0.329*	3.660	1.188	15.832
	BHD	JPY	CHF	0.134	0.171*	2.205	1.052	4.900
	BHD	JPY	GBP	0.080	-0.148	-1.401	1.040	3.867
7) Nonlinear ECM								
	BHD	CHF	JPY	0.216	0.515*	2.354	1.049	4.682
	BHD	CHF	GBP	0.329	0.537*	3.348	1.190	15.968
	BHD	GBP	JPY	0.224	-0.221	-1.330	1.040	3.820
	BHD	GBP	CHF	0.303	0.321*	3.534	1.189	15.897
	BHD	JPY	CHF	0.170	0.197*	2.486	1.044	4.188
	BHD	JPY	GBP	0.081	-0.140	-1.235	1.040	3.841
8) ARDL(1,1)								
	BHD	CHF	JPY	0.119	0.446*	2.005	1.054	5.132
	BHD	CHF	GBP	0.207	0.609*	3.563	1.185	15.624
	BHD	GBP	JPY	0.102	-0.186	-1.081	1.038	3.621
	BHD	GBP	CHF	0.267	0.322*	3.563	1.189	15.889
	BHD	JPY	CHF	0.066	0.161*	2.005	1.053	5.068
	BHD	JPY	GBP	0.044	-0.118	-1.081	1.038	3.657
9) ARDL(1,1) long-run								
	BHD	CHF	JPY	0.119	0.460*	1.938	1.053	5.069
	BHD	CHF	GBP	0.207	0.308*	1.627	1.152	13.158
	BHD	GBP	JPY	0.102	-0.452	-1.377	1.014	1.373
	BHD	GBP	CHF	0.267	0.690*	2.382	1.107	9.655
	BHD	JPY	CHF	0.066	0.375*	1.763	1.111	10.006
	BHD	JPY	GBP	0.044	-0.332	-1.628	1.012	1.175

* Significant at the 5% level

CHAPTER EIGHT

CONCLUSION

8.1 Recapitulation

This thesis is concerned with the management of foreign-exchange risk from the perspective of firms working in a member country of the GCC. The aim of this thesis is to address the following important problems related to hedging, and which represent a major concern for these firms. These questions are (i) to hedge or not to hedge; (ii) the hedging instrument which should be used to hedge the exposure; and (iii) the econometric model which should be used to estimate the hedge ratio. To be more specific, the main focus of this thesis will be on the following four issues:

1- Comparing the effectiveness of three hedging strategies: (i) always hedge; (ii) to hedge or not to hedge; and (iii) always not hedge.

2- Comparing the effectiveness of three financial-hedging techniques: (i) money-market hedging; (ii) forward hedging; and (iii) cross-currency hedging.

3- Comparing the effectiveness of financial hedging with that of operational hedging, such as (i) currency collars; (ii) risk-sharing arrangements; and (iii) hybrid arrangements.

4- Examining whether or not the techniques used to estimate the hedge ratio make any difference to the effectiveness of the hedge.

The results obtained in this study are largely consistent with the available evidence. For example, it was found that model specification has no value added in terms of hedging effectiveness. In view of the results, the contribution of this thesis can be summarised as follows:

1- It will benefit the managers of firms engaged in international trade as well as researchers interested in foreign-exchange risk management.

2- It will add value to firms operating in developing markets that lack sophisticated financial-hedging instruments.

3- It will benefit investment banks in offering different hedging instruments for their clients, and will widen their awareness of the efficiency of each hedging technique. It will also help these banks to suggest to their clients the most suitable instrument compared to the traditional ones.

4- It will fill the a gap in the literature, as this thesis is unique in the sense that it covers countries that adopt a fixed-exchange-rate regime in which all of the currencies are pegged to the USD, except for Kuwait, which pegs its currency to a basket of currencies. This area has not been studied extensively in the literature.

This thesis consists of eight chapters starting with an introduction and overview in the first chapter. In Chapter 2 we explore the measurements of foreign-exchange risk management and explain the differences between foreign-exchange risk and foreign-exchange exposure. In addition, we illustrate the different types of exposures that challenge a multinational firm. Chapter 3 demonstrates the different techniques that are used to manage exposure to foreign-exchange risk. These techniques range from financial-hedging techniques to operational-hedging techniques. The empirical work of this thesis is reported in Chapters 4, 5, 6, and 7. Chapter 4 answers the question: ‘Do we need to hedge?’ by forecasting the spot rate and comparing it with the actual forward rate. The results show that, on average, there is no difference in performance and risk under these hedging strategies for all of the GCC currencies against foreign currencies.

The comparative effectiveness of three financial-hedging techniques—forward-hedging, money-market hedging and cross-currency hedging—is examined in Chapter 5. The results show that there is no difference in whether we use forward-hedging or money-market hedging. However, in relation to a cross-currency hedge, the results are mixed, as the effectiveness of the hedge for cross-currency hedging depends on the correlation between the exposure-currency exchange rate and the hedged-currency exchange rate.

In Chapter 6 we compare the effectiveness of financial-hedging versus operational-hedging techniques. These operational-hedging techniques are the risk-sharing arrangement, currency collars, and hybrid arrangements. The results show that forward hedging is more effective than either risk-sharing arrangements or hybrid arrangements. However, when compared with currency collars, the results are mixed. An examination of the different financial-econometrics models that are usually used to measure the hedge ratio is presented in Chapter 7. The results show that these econometric models fail either to add value or to improve the effectiveness of the hedge.

8.2 Limitations and Future Research

During the preparation of this thesis, we encountered several limitations related to data availability. This problem is normal for researchers working with data for developing countries. For example Oman is excluded from this study because of inaccurate exchange-rate data and the unavailability of interest rates. In addition, the sample period for each country in this study is not exactly the same because of a lack of interest-rate data for most of the countries at the time of collecting the data. The limitations not only relate to developing countries, they are also related to developed countries such as Switzerland, where the monthly industrial-production data that are needed for the forecasting model last until November 2011.

Through our reading of the literature, we think that the GCC markets not only lack sophisticated hedging instruments, but also research and studies that cover the foreign-exchange risk-management topic. Therefore, we suggest that the following topics be investigated in the future by researchers who are interested in this field:

- Study the determinants of derivatives usage among non-financial firms in the GCC.
- Compare different hedging instruments using a survey to discover the most-often used instrument.
- Study the relationship between the value of the firm and the use of derivatives in the GCC.
- Estimate optimal hedge ratios using dynamic econometric models and compare them to the static ones.

We hope to have the chance in the future to cover those interesting topics.

REFERENCES

Adler, M. and Dumas, B. (1984) Exposure to Currency Risk: Definition and Measurement, *Financial Management*, Vol. 13, pp. 41-50.

Aggarwal, R. and Soenen, L. (1989) Managing Persistent Real Changes in Currency Values: The Role of Multinational Operating Strategies, *Columbia Journal of World Business*, Vol. 24, pp. 60-67.

Aggarwal, R. and Harper, J. (2010) Foreign Exchange Exposure of Domestic Corporations, *Journal of International Money and Finance,* Vol. 29, pp.1619-1636.

Albuquerque, R. (2007) Optimal Currency Hedging, *Global Finance Journal*, Vol.18, pp. 16-33.

Al-Loughani, N. and Moosa, I. (2000) Covered Interest Parity and the Relative Effectiveness of Forward and Money Market Hedging, *Applied Economics Letters*, Vol. 7, pp. 673-675.

Alexander, C. (1999) Optimal Hedging Using Cointegration, *Philosophical Transactions of The Royal Society Series A*, ICMA Centre, Reading University, 357, Vol. 357, pp. 2039-2058.

Alexander, C. and Barbosa, A. (2007) Effectiveness of Minimum-Variance Hedging, *Journal of Portfolio Management,* Vol. 33, pp. 46-59.

Alexander, C., Prokopczuk, M. and Sumawong, A. (2013) The (De)merits of Minimum Variance Hedging: Application to the Crack Spread, *Energy Economics*, Vol. 36, pp. 698-707.

Allayannis, G., Ihrig, J. and Weston, J. (2001) Exchange-Rate Hedging: Financial versus Operational Strategies, *American Economic Review*, Vol. 91, pp. 391-395.

Baillie, R. and Myers, R. (1991) Bivariate GARCH Estimation of the Optimal Commodity Futures Hedge, *Journal of Applied Econometrics*, Vol. 6, pp. 109-124.

Batten, J., Mellor, R. and Wan, V. (1993) Foreign Exchange Risk Management Practices and Products used by Australian Firms, *Journal of International Business Studies,* Vol. 24, pp. 557–573.

Benet, B. (1990) Commodity Futures Cross Hedging of Foreign Exchange Exposure, *Journal of Futures Markets,* Vol. 10, pp. 287-306.

Benet, B. (1992) Hedging Period Length and Ex-ante Futures Hedging Effectiveness: The Case of Foreign Exchange Risk Cross Hedges, *Journal of Futures Markets*, Vol. 12, pp. 163-175.

Bessembinder, H. (1991) Forward Contracts and Firm Value: Investment Incentive and Contracting Effects, *Journal of Financial and Quantitative Analysis,* Vol. 26, pp. 519-532.

Belk, P. and Glaum, M. (1990) The Management of FX Risk in UK Multinationals, *Accounting and Business Research,* Vol. 21, pp. 3-14.

Belk, P. and Glaum, M. (1992) Financial Innovations: Some Evidence From the UK, *Managerial Finance*, Vol. 18, pp. 71-86.

Belk, P. and Edelshain, D. (1997) Foreign Exchange Risk Management—The Paradox, *Managerial Finance,* Vol. 23, pp. 5-24.

Bodnar, G., Hayt, G., Marston, R. and Smithson, C. (1995) Wharton Survey of Derivative Usage by US Non-Financial Firms, *Financial Management* Vol. 24, pp. 104-105.

Bodnar, G., Hayt, G. and Marston, R. (1996) 1995 Wharton Survey of Derivative Usage by US Non-Financial Firms, *Financial Management,* Vol. 25, pp. 113-133.

Bodnar, G., Hayt, G. and Marston, R. (1998) 1998 Wharton Survey of Derivative Usage by US Non–Financial Firms, *Financial Management,* Vol. 27, pp. 70-92.

Bradley, K. and Moles, P. (2002) Managing Strategic Exchange Rate Exposures: Evidence from UK Firms, *Managerial Finance*, Vol. 28, pp. 28-42.

Brooks, C., Davies, R. and Kim, S. (2006) Cross Hedging with Single Stock Futures, Available at http://faculty.babson.edu/rdavies/cross%20hedging%20with%20single%20stock%20futures%20R2.pdf

Brooks, C. and Chong, J. (2001) The Cross Currency Hedging Performance of Implied versus Statistical Forecasting Models, *Journal of Futures Markets*, Vol. 21, pp. 1043-1069.

Brooks, C. (2014) *Introductory Econometrics for Finance*. Cambridge: Cambridge University Press.

British Petroleum (2014) BP Statistical Review of World Energy June 2014, 63rd Edition, http://www.bp.com/content/dam/bp/pdf/Energy-economics/statistical-review-2014/BP-statistical-review-of-world-energy-2014-full-report.pdf

Cecchetti, S. G., Cumby, R. E. and Figlewski, S. (1988) Estimation of the Optimal Futures Hedge, *Review of Economics and Statistics*, Vol. 70, pp. 623-30.

Charumathi, B. and Kota, H. (2012) On the Determinants of Derivative Usage by Large Indian Non-financial Firms, *Global Business Review*, Vol. 13, pp. 251-267.

Chen, S., Lee, C. and Shrestha, K. (2003) Futures Hedge Ratio: A Review, *Quarterly Review of Economics and Finance*, Vol. 43, pp. 433-465.

Chow, K., Broll, U. and Wong, K. (2000) Hedging and Nonlinear Risk Exposure, Hong Kong Institute of Business Studies, Working Paper Series, Paper 30.

Chowdhry, B. and Howe, J. (1999) Corporate Risk Management for Multinational Corporations: Financial and Operating Hedging Policies, *European Financial Review*, Vol. 2, pp. 229-246.

Chong, L., Chang, X. and Tan, S. (2014) Determinants of Corporate Foreign Exchange Risk Hedging, *Managerial Finance*, Vol. 40, pp. 176-188.

Chou, W., Denis, K. and Lee, C. (1996) Hedging with Nikkei Index Futures: The Conventional Model versus the Error Correction Model, *Quarterly Review of Economics and Finance*, Vol. 36, pp. 495-505.

Clark, E. and Ghosh, D. (2004) *Arbitrage, Hedging and Speculation: The Foreign Exchange Market*. Connecticut: Praeger Publishers.

Coffey, B., Anderson, J. and Parcell, J. (2000) Optimal Hedging Ratios and Hedging Risk for Grain by-Products, *AAEA Annual Meeting*, Tampa Bay, Florida, 28-31/2000.

Copeland, T., Weston, J. and Shastri, K. (2005) *Financial Theory and Corporate Policy*. Boston, MA: Addison-Wesley Publishing Company.

Copeland, L. and Zhu, Y. (2006) Hedging Effectiveness in the Index Futures Market, Working Paper E2006/10, Cardiff Business School.

Davies, D., Eckberg, C. and Marshall, A. (2006) The Determinants of Norwegian Exporters' Foreign Exchange Risk Management, *European Journal of Finance*, Vol. 12, pp. 217-240.

DeMarzo, P. and Duffie, D. (1995) Corporate Incentives for Hedging and Hedge Accounting, *Review of Financial Studies*, Vol. 8, pp. 743-771.

Dhani, A. and Groves, R. (2001) The Management of the Strategic Exchange Risk: Evidence from Corporate Practices, *Accounting and Business Research*, Vol. 31, pp. 275-290.

Dolde, W. (1993) The Trajectory of Corporate Financial Risk Management, *Continental Bank Journal of Applied Corporate Finance*, Vol. 6, pp. 33-41.

Dong, L., Kouvelis, P. and Su, P. (2014) Operational Hedging Strategies and Competitive Exposure to Exchange Rates, *International Journal of Production Economics*, Vol. 153, pp. 215-229.

Duangploy, O., Bakay, V. and Belk, P. (1997) The Management of Foreign Exchange Risk in US Multinational Enterprises: An Empirical investigation. *Managerial Finance,* Vol. 23, pp. 85-100.

Dufey, G. and Srinivasulu, S. (1983) The Case for Corporate Management of Foreign Exchange Risk, *Financial Management*, Vol. 12, pp. 54-60.

Eaker, M. and Grant, D. (1987) Cross Hedging Foreign Currency Risk, *Journal of International Money and Finance*, Vol. 6, pp. 85-105.

Eaker, M. and Grant, D. (1990) Currency Hedging Strategies for Internationally Diversified Equity Portfolios, *Journal of Portfolio Management*, Vol. 17, pp. 30-32.

Ederington, L. (1979) The Hedging Performance of the New Futures Markets, *Journal of Finance*, Vol. 34, pp. 157-170.

Engle, R. and Granger, C. (1987) Cointegration and Error Correction: Representation, Estimation and Testing, *Econometrica*, Vol. 55, pp. 251-276.

El-Masry, A. (2003) A Survey of Derivatives Use by UK Non-Financial Companies, Social Science Research Network, Manchester Business School 445-03.

Escribano, A. (1978) Error Correction Systems: Nonlinear Adjustments to Linear Long-run Relationships, CORE Discussion Papers 8730.

Eun, C. and Resnick, B. (1994) International Diversification of Investment Portfolios: US and Japanese Perspective, *Management Science*, Vol. 40, pp. 140-161.

Eun, C. and Resnick, B. (1997) International Equity Investment with Selective Hedging Strategies, *Journal of International Financial Markets* Vol. 7, pp. 21-42.

Eun, C. and Resnick, B. (2009) *International Financial Management*. New York: McGraw Hill.

Froot, K.A. (1993) Currency Hedging Over Long Horizons. NBER Working Paper Series, 4355.

Froot, K., Scharfstein, D. and Stein, J. (1993) Risk Management: Coordinating Corporate Investment and Financing Policies, *Journal of Finance*, Vol. 48, pp. 1629-1658.

Froot, K., Scharfstein, D. and Stein, J. (1994) A Framework for Risk Management, *Harvard Business Review,* Vol. 72, pp. 91-103.

Gay, G. and Nam, J. (1998) The Underinvestment Problem and Corporate Derivatives Use, *Financial Management*, Vol. 27, pp. 53-69.

Geczy, C, Minton, B. and Schrand, C. (1997) Why Firms Use Currency Derivatives, *Journal of Finance,* Vol. 52, pp. 1323-1354.

Ghosh, A. (1993) Hedging with Stock Index Futures: Estimation and Forecasting with Error Correction Model, *Journal of Futures Markets*, Vol. 13, pp. 743-752.

Ghosh, A. (1995) The Hedging Effectiveness of ECU Futures Contracts: Forecasting, Evidence from an Error Correction Model, *Financial Review*, Vol. 30, pp. 567-581.

Ghosh, A. (1996) Cross Hedging Foreign Currency Risk: Empirical Evidence from an Error Correction Model, *Review of Quantitative Finance and Accounting*, Vol. 6, pp. 223-231.

Glen, J. and Jorion, P. (1993) Currency Hedging for International Portfolios, *Journal of Finance,* Vol. 48, pp. 1865-1886.

Graham, J. and Rogers, D. (2002) Do Firms Hedge in Response to Tax Incentives? *Journal of Finance,* Vol. 57, pp. 815-840.

Graff, J., Schroder, T., Jones, R. and Dhuyvetter, K. (1997) Cross Hedging Agricultural Commodities, Working Paper, Kansas State University, Cooperative Extension Service Bulletin, MF-2284.

Grant, D. and Eaker, M. (1989) Complex Hedges: How Well Do They Work? *Journal of Futures Markets*, Vol. 9, pp. 15-27.

Gujarati, D. (2003) *Basic Econometrics,* New York: McGraw-Hill.

Hagelin, N. (2003) Why Firms Hedge with Currency Derivatives: An Examination of Transaction and Translation Exposure, *Applied Financial Economics*, Vol. 13, pp. 55-69.

Hakkarainen, A., Joseph, N., Kasanen, E. and Puttonen, V. (1998) The Foreign Exchange Exposure Management Techniques of Finnish Industrial Firms, *Journal of International Finance and Management Accounting,* Vol. 9, pp. 34-57.

Hanna, D. (2008) The Gulf's Changing Financial Landscape: From Capital Source to Destination and Emerging Hub; *The Gulf Region, A New Hub of Global Financial Power E*dited by John Nugee and Paola Subacchi, Chatham House, London.

Hatemi-J, A. and Roca, E. (2006) Calculating the Optimal Hedge Ratio: Constant, Time Varying and the Kalman Filter Approach, *Applied Economics Letters*, Vol. 13, pp. 293-299.

Hatemi-J, A. and Roca, E. (2010) Estimating Optimal Hedge Ratio with Unknown Structural Breaks, Working Paper 2010:10, Griffith Business School.

Hatemi-J, A. and El-Khatib, Y. (2012) Stochastic Optimal Hedge Ratio: Theory and Evidence, *Applied Economics Letters*, Vol. 19, pp. 699-703.

Hill, J. and Schneeweis, T. (1981) A Note on the Hedging Effectiveness of Foreign Currency Futures, *Journal of Futures Markets*, Vol. 1, pp. 659-664.

Hill, R., Griffiths, W. and Lim, G. (2011) *Principles of Econometrics*, 4th Edition, MA: John Wiley and Sons.

Hendry, D. and Eriscon, N. (1991) An Econometric Analysis of the UK Money Demand in Milton Friedman, M. and Schwartz, A. 'Monetary Trends in the United States and the United Kingdom', M*onetary Trends in the United Kingdom*, Bank of England Panel of Academic Consultants, Paper 22, pp. 45-101.

Herbst, A., Kare, D. and Marshall, J. (1993) A Time Varying, Convergence Adjusted, Minimum Risk Futures Hedge Ratio, *Advances in Futures and Options Research*, Vol. 6, pp. 137-155.

Ho, T. (2002) The Forward Rate Unbiasedness Hypothesis Revisited, *Applied Financial Economics*, Vol. 12, pp. 799-804.

Hommel, U. (2003) Financial versus Operative Hedging of Currency Risk, *Global Finance Journal, Vol.* 14, pp. 1-18.

Howard, C. and D'Antonio, L. (1984) A Risk-Return Measure of Hedging Effectiveness, *Journal of Financial and Quantitative Analysis*, Vol. 1, pp. 659-664.

Howton, S. and Perfect, S. (1998) Currency and Interest-rate Derivatives Use in U.S. Firms, *Financial Management*, Vol. 27, pp. 111-121.

Hull, J. (2011) *Options, Futures, and Other Derivatives*. Boston: Prentice Hall.

Huston, E, and Laing, E. (2014) Foreign Exchange Exposure and Multinationality, *Journal of Banking and Finance*, Vol. 43, pp. 97-113.

Jesswein, K., Kwok, C. and Folks, W. (1995) Corporate Use of Innovative Foreign Exchange Risk Management Products, *Columbia Journal of World Bank*, Vol. 30, pp. 70-82.

Jilling, M. and Folks, W. (1977) A Survey of Corporate Exchange Rate Forecasting Practices, Working Paper No. 3, Centre for International Business Studies, University of South Carolina, Columbia.

Johnson, L. (1960) The Theory of Hedging and Speculation in Commodity Futures, *Review of Economic Studies*, Vol. 27, pp. 139-151.

Jong, A., Roon, F., and Veld, C. (1995) An Empirical Analysis of The Hedging Effectiveness of Currency Futures, Discussion Paper, Tilburg University, Center for Economic Research.

Jong, A., De Roon, F. and Veld, C. (1997) Out of the Sample Hedging Effectiveness of Currency Futures for Alternative Models and Hedging Strategies, *Journal of Futures Markets*, Vol. 17, pp. 817-837.

Joseph, N. and Hewins, R (1991) Portfolio Models for Foreign Exchange Exposure, *International Journal of Management Science*, Vol. 19, pp. 247-258.

Joseph, N. (2000) The Choice of Hedging Techniques and the Characteristics of UK Industrial Firms, *Journal of Multinational Financial Management*, Vol. 10, pp. 161-184.

Jorion, P. (1990) The Exchange-Rate Exposure of U.S. Multinationals, *Journal of Business*, Vol. 63, pp. 331-345.

Junkus, J. and Lee, C. (1985) Use of Three Index Futures in Hedging Decisions, *Journal of Futures Mar*kets, Vol. 5, pp. 201-222.

Jung, C., Doroodian, K. and Albarano, R. (1998) The Unbiasdness Forward Rate Hypothesis: A Re-examination, *Applied Financial Economics*, Vol. 8, pp. 567-575.

Kenourgios, D., Samitas, A. and Drosos, P. (2008) Hedge Ratio Estimation and Hedging Effectiveness: The Case of the S&P 500 Stock Index Futures Contract, *International Journal of Risk Assessment and Management*, Vol. 9, pp. 121-134.

Khoury, S. and Chan, K. (1988) Hedging Foreign Exchange Risk: Selecting the Optimal Tool, *Midland Corporate Finance Journal*, Vol. 5, pp. 40-52.

Kolb, R. and Okunev, J. (1992) An Empirical Evaluation of the Extended Mean-Gini Coefficient for Futures Hedging, *Journal of Futures Markets*, Vol. 12, pp. 177-186.

Kolb, R. and Okunev, J. (1993) Utility Maximizing Hedge Ratios in The Extended Mean-Gini Framework, *Journal of Futures Markets*, Vol. 13, pp. 597-609.

Kroner, K. and Sultan, J. (1993) Time Varying Distributions and Dynamic Hedging with Foreign Currency Futures, *Journal of Financial and Quantitative Analysis,* Vol. 28, pp. 535-551.

Lence, S. (1995) The Empirical Minimum Variance Hedge, *American Journal of Agricultural Economics*, Vol. 76, pp. 94-104.

Levi, M. (2005) *International Finance*. New York: Routledge

Lien, D. (1996) The Effect of the Cointegration Relationship on Futures Hedging: A Note, *Journal of Futures Markets*, Vol. 16, pp. 773-780.

Lien, D. and Luo, X. (1993) Estimating Multiperiod Hedge Ratios in Cointegrated Markets, *Journal of Futures Market*s, Vol. 13, pp. 909-920.

Lien, D. and Tse, Y. (2001) Hedging Downside Risk: Futures versus Options, *International Review of Economics and Finance*, Vol. 10, pp. 159-169.

Lien, D. and Tse, Y. (2002) Some Recent Developments in Futures Hedging, *Journal of Economic Surveys*, Vol. 16, pp. 357-396.

Lien, D., Tse, Y. and Tsui, A. (2002) Evaluating the Hedging Performance of the Constant Correlation GARCH Models, *Applied Financial Economics*, Vol. 12, pp. 791-798.

Lindahl, M. (1991) Risk-Return Hedging Effectiveness Measures for Stock Index Futures, *The Journal of Futures Markets*, Vol. 11, pp. 399-409.

Logue, D (1995) When Theory Fails: Globalization as Response to the (Hostile) Market for Foreign Exchange, *Journal of Applied Corporate Finance*, Vol. 8, pp. 39-48.

Maharaj, E, Moosa, I, Jonathan, D. and Silvapulle, P. (2008) Wavelet Estimation of Asymmetric Hedge Ratios: Does Econometric Sophistication Boost Hedging Effectiveness?, *International Journal of Business and Economics*, Vol. 7, pp. 213-230.

Malliaris, A. and Urrutia, J. (1991) The Impact of the Lengths of Estimation Periods and Hedging Horizons on The Effectiveness of a Hedge: Evidence from Foreign Currency Futures, *Journal of Futures Markets*, Vol. 11, pp. 271-289.

Marshall, A. (2000) Foreign Exchange Risk Management in UK, USA, Asia Pacific Multinational Companies, *Journal of Multinational Financial Management*, Vol. 10, pp. 185-211.

McCarthy, S. (2002) A Simulation Analysis of the Performance of Foreign Exchange Exposure Management Strategies, *International Journal of Business Studies*, Vol. 10, pp. 27-44.

McCarthy, S. (2003) Hedging versus Not Hedging: Strategies for Managing Foreign Exchange Transaction Exposure, *Discussion Papers in Economics, Finance and International Competitiveness*, Discussion Paper No. 162, Working Paper.

McDonald, B. and Moosa, I. (2003) Risk Sharing Arrangements and Currency Collars as an Alternative to Financial Hedging of Exposure to Foreign Exchange Risk, *Journal of Accounting and Finance*, Vol. 2, pp. 63-79.

Mitra, D. and Rinco, V. (1996) Hedging Strategies on Four International Equity Indices: A Canadian Perspective, *Mid-Atlantic Journal of Business*, Vol. 32, pp. 171-188.

Miller, T., Kim, A. and Holmes, K. (2014) *The Index of Economic Freedom: Promoting Economic Opportunity and Prosperity*, The Heritage Foundation http://www.heritage.org/index/about

Moosa, I. (2000a) *Exchange Rate Forecasting: Techniques and Applications*. London Palgrave Macmillan.

Moosa, I. (2000b) A Structural Time Series Test of the Monetary Model of Exchange Rate under the German Hyperinflation, *Journal of International Financial Markets*, Institutions and Money, Vol. 10, pp. 213-223.

Moosa, I. (2001) Direct and Cross Forward Hedging of Transaction Exposure to Foreign Exchange Risk, *Journal of International Economic Studies*, Vol. 15, pp. 143-152.

Moosa, I. (2002) A Test of the News Model of Exchange Rates, *Weltwritschaftliches Archiv*, Vol. 138, pp. 694-710.

Moosa I. (2003a) The Sensitivity of the Optimal Hedge Ratio to Model Specification, *Finance Letters*, Vol. 2, pp. 32-37.

Moosa, I. (2003b) *International Financial Operations: Arbitrage, Hedging, Speculation, Financing and Investment*. London: Palgrave.

Moosa, I. (2003c) The Effectiveness of Cross-Currency Hedging, *Finance Letters*, Vol. 1, pp. 15-20.

Moosa, I. (2004b) Is There a Need for Hedging Exposure to Foreign Exchange Risk? *Applied Financial Economics*, Vol. 14, pp. 279-283.

Moosa, I. and Lien, D. (2004) A Bargaining Approach to Currency Collars, *Research in International Business and Finance*, Vol. 18, pp. 229-236.

Moosa, I. and McDonald, B. (2005) Operational Hedging as an Alternative to Financial Hedging in the Absence of Sophisticated Financial Markets, *Economia Internazionale*, Vol. 58, pp. 241-254.

Moosa, I. (2006a) Cross Currency Hedging as an Alternative to Forward and Money Market Hedging in an Emerging Financial Market, *International Economics and Finance Journal*, Vol. 1, pp. 95-105.

Moosa, I. (2006b) A Hybrid Operational Technique for Hedging Transaction Exposure to Foreign Exchange Risk, *Global Finance Conference 26/4/2006,* Rio de Janiero, Brazil.

Moosa, I. (2009) Hedging Transaction Exposure to Foreign Exchange Risk by Using Risk Sharing Arrangements and Currency Collars, *International Review of Applied Financial Issues and Economics*, Vol. 1, pp. 107-129.

Moosa, I. (2010) *International Finance: An Analytical Approach*. Sydney: McGraw-Hill.

Moosa, I. (2011a) The Failure of Financial Econometrics: Estimation of the Hedge Ratio as an Illustration, *Journal of Financial Transformation*, Vol. 31, pp. 67-71.

Moosa, I. (2011b) Risk Transfer Arrangements as a Hedging Device with Evidence from the Kuwaiti Dinar-British Pound Market, *Review of Middle East Economics and Finance*, Vol. 7, pp. 1-18.

Modigliani, F. and Miller, M. (1958) The Cost of Capital, Corporation Finance and the Theory of Investment, *American Economic Review*, Vol. 48, pp. 261–297.

Morey, M. and Simpson, M. (2001) To Hedge or Not To Hedge: The Performance of Simple Strategies for Hedging Foreign Exchange Risk, *Journal of Multinational Financial Management*, Vol. 11, pp. 213-223.

Muller, A. and Verschoor, W. (2006) Foreign Exchange Risk Exposure: Survey and Suggestions, *Journal of Multinational Financial Management*, Vol. 16, pp. 385-410.

Myers, R. and Thompson, S. (1989) Generalized Optimal Hedge Ratio Estimation, *American Journal of Agricultural Economics*, Vol. 71, pp. 858-867.

Naylor, M. and Greenwood, R. (2006) The Characteristics of Foreign Exchange Hedging: A Comparative Analysis, Available at SSRN: http://ssrn.com/abstract=1026157

OPEC (2014) OPEC Annual Statistical Bulletin, Organization of the Petroleum Exporting Countries, Vienna, Austria, http://www.opec.org/opec_web/static_files_project/media/downloads/publications/ASB2014.pdf

Pantzalis, C., Simkins, B. and Laux, P. (2001) Hedges and the Foreign Exchange Exposure of U.S. Multinational Corporations, *Journal of International Business Studies*, Vol. 32, pp. 793-812.

Park, S. and Jei, S. (2010) Estimation and Hedging Effectiveness of Time Varying Hedge Ratio: Flexible Bivariate GARCH Approaches, *Journal of Futures Markets,* Vol. 30, pp. 71-99.

Perold, A. and Schulman, E. (1988) The Free Lunch in Currency Hedging: Implications for Investment Policy and Performance Standards, *Financial Analysts Journal*, Vol. 44, pp. 45-50.

Pramborg, B. (2005) Foreign Exchange Risk Management by Swedish and Korean Nonfinancial Firms: A Comparative Survey, *Pacific-Basin Finance Journal*, Vol. 13, pp. 343-336.

Rawls, S. and Smithson, C. (1990) Strategic Risk Management, *Journal of Applied Corporate Finance*, Vol. 1, pp. 6-18.

Rivero, S. and Park, Y. (1992) Further Tests on the Forward Exchange Rate Biasedness Hypothesis, *Economic Letters,* Vol. 40, pp. 325-331.

Rodriguez, R. (1979) Currency Risk—How the Fear of Reporting a Loss Distorts Hedging Decisions, *Euromoney*, pp 98-104.

Rodriguez, R. (1980) *Foreign Exchange Management in U.S. Multinationals*. Lexington, Massachusetts: D.C. Heath and Company.

Rodriguez, R. (1981) Corporate Exchange Rate Risk Management: Theme and Aberrations. *Journal of Finance,* Vol. 36, pp. 427-439.

Schwab, B. and Peter Lusztig, P. (1978) Foreign Exchange Risk through the Use of Third Currencies: Some Questions on Efficiency, *Financial Management Journal*, Vol. 7, pp. 25-30.

Scholes, M. and Williams, J. (1977) Estimating Betas from Nonsynchronous Data, *Journal of Financial Economics,* Vol. 5, pp. 309-327.

Seddighi, H., Lawler, K. and Katos, A. (2000) *Econometrics: A Practical Approach*. New York: Routledge.

Sephton, P. (1993) Hedging Wheat and Canola at the Winnipeg Commodity Exchange, *Applied Financial Economics,* Vol. 3, pp. 67-72.

Shapiro, A. (2010) *Multinational Financial Management*, 9th Edition, New Jersey: John Wiley and Sons, Inc.

Simpson, M. and Dania, A. (2006) Selectively Hedging the Euro, *Journal of Multinational Financial Management,* Vol. 16, pp. 27-42.

Smith, C., Smithson, C. and Wilford, D. (1989) *Managing Financial Risk*. New York: Harper & Row, Ballinger Division.

Smith, C. and Stulz, R. (1985) The Determinants of Firm's Hedging Policies. *Journal of Financial and Quantitative Analysis,* Vol. 20, pp. 391-405.

Studenmund, A. (2011) *Using Econometrics: A Practical Guide*. Boston: Pearson Addison Wesley.

Stulz, R. (1984) Optimal Hedging Policies, *Journal of Financial and Quantitative Analysis,* Vol. 19, pp. 127-140.

Stulz, R. (1996) Rethinking Risk Management, *Journal of Applied Corporate Finance,* Vol. 9, pp. 8-24.

Stulz, R. (2003) *Risk Management and Derivatives*. Ohio: Thomson South-Western.

Stulz, R. (2013) How Companies Can Use Hedging to Create Shareholder Value, *Journal of Applied Corporate Finance*, Vol. 25, pp. 21-29.

Suh, S. (2011) Currency Hedging Failure in International Equity Investments and An Efficient Hedging Strategy: The Perspective of Korean Investors, *Pacific-Basin Finance Journal*, Vol. 19, pp. 390-403.

Sovereign Wealth Fund Institute (2015) SWF Rankings, http://www.swfinstitute.org/fund-rankings/

Tran, V. (1979, 1980) *Foreign Exchange Management in Multinational Firms*. Michigan: UMI Research Press.

UNCTAD (2014) *World Investment Report: Global Value Chains: Investing in the SDGs: An Action Plan,* New York and Geneva, United Nations, http://unctad.org/en/PublicationsLibrary/wir2014_en.pdf

UNDP (2014) *Human Development Report 2014: Sustaining Human Progress: Reducing Vulnerabilities and Building Resilience,* New York, http://hdr.undp.org/sites/default/files/hdr14-report-en-1.pdf

Vij, M. (2009) Foreign Exchange Management Practices of Indian Firms: An Empirical Analysis, Available at SSRN:http://ssrn.com/abstract=1331760

Wang, Y., Chongfeng, W. and Yang, L. (2015) Hedging with Futures: Does Anything Beat the Naïve Hedging Strategy?, *Management Science,* Vol. 60, pp. 796-804.

Weber, E. (2008) A Short History of Derivatives Security Markets, Discussion Paper, The University of Western Australia, http://www.uwa.edu.au/__data/assets/pdf_file/0003/94260/08_10_Weber.pdf

Witt, H., Schroder, T. and Hayenga, M. (1987) Comparison of Analytical Approaches for Estimating Hedge Ratios for Agricultural Commodities, *Journal of Futures Markets*, Vol. 7, pp. 135-146.

Wilson, W. (1983) Hedging Effectiveness of US Wheat Futures Markets, *Review of Research in Futures Markets*, Vol. 3, pp. 64-67.

Working, H. (1962) New Concepts Concerning Futures Markets and Prices, *American Economic Review,* Vol. 52, pp. 431-459.

Wolff, C. (2000) Forward Foreign Exchange Rates and Expected Future Spot Rates, *Applied Financial Economics*, Vol. 10, pp. 371-377.

World Bank (2014) *Doing Business Report 2015: Going beyond Efficiency*, Washington DC, https://openknowledge.worldbank.org/bitstream/handle/10986/20483/DB15-Full-Report.pdf?sequence=1

Wooldridge, J. (2009) *Introductory Econometrics: A Modern Approach*, 4th Edition, Ohio: South-Western Cengage Learning.

Yeandle, M. and Danev, N. (2014) *The Global Financial Centres Index 15 Edition in March 2014,* Long Finance's Financial Center Futures' program , Qatar Financial Center, http://www.luxembourgforfinance.com/sites/luxembourgforfinance/files/files/GFCI15_March_2014.pdf

Zhou, V. and Wang, P. (2013) Managing Foreign Exchange Risk with Derivatives in UK Non-Financial Firms, *International Review of Financial Analysis*, Vol. 29, pp. 294-302.